HSNC UNIVERSITY, MUMBAI

Board of Faculty of Science & Technology

Board of Studies in the Subjects of Statistics and Data Science & Business Analytics

1) **Name of Chairperson/Co-Chairperson/Coordinator:-**

   a) Dr Asha Jindal, Associate Professor and Head, Department of Statistics, K. C. college, HSNC University Churchgate, Mumbai –400 020. Email ID- asha.jindal@kccollege.edu.in Mobile no- 9821235627

2) **Two to five teachers each having minimum five years teaching experience amongst the full time teachers of the Departments, in the relevant subject.**

   a) **Dr. S. B. Muley,** Assistant Professor, Department of Statistics, K. C. college, HSNC University Churchgate, Mumbai – 400 020. Email ID sakharam.muley@kccollege.edu.in , Mobile No- 9323817918

   b) **Mrs. Pratiksha Kadam,** Assistant Professor, Department of Statistics, K. C. college, HSNC University Churchgate, Mumbai – 400 020. Email ID pratiksha.kadam@kccollege.edu.in , Mobile No- 7507162816

   c) **Ms. Shailaja Rane,** Assistant Professor, Department of Statistics, K. C. college, HSNC University Churchgate, Mumbai – 400 020. Email ID shailaja.rane@kccollege.edu.in, Mobile No- 7506986359

3) **One Professor / Associate Professor from other Universities or professor / Associate Professor from colleges managed by Parent Body;**

   a) **Dr Anjum Ara Ahmed;** I/C Principal, Rizvi College, Mumbai. Email ID **anjumahmed8@gmail.com, Mobile No-** 8451046220

4) **Four external experts from Industry / Research / eminent scholar in the field relevant to the subject nominated by the Parent Body;**

a. **Prof. Suresh Kumar Sharma,** Professor, Department of Statistics, Panjab University, Chandigarh. Email ID ssharma643@yahoo.co.in, **Mobile No**-9815911381

b. **Mr Mukesh Jain,** Chief Technological Officer, Capgemini. Email ID mdjain@hotmail.com, **Mobile No**-7972637347.

c. **Dr Santosh Gite,** Associate Professor, Dept. of Statistics, University of Mumbai, Mumbai. Email ID santgite@yahoo.com, **Mobile No-** 9167157717.

d. **Mr Prashant Kumar Nair,** Director, Geo Spatial Analytics Global Lead, Intelligent Analytics, Nielsen Connect, Email ID prashantkumar.nair@nielsen.com , **Mobile No**-9833747057.

5. Top rankers of the Final Year Graduate and Final Year Post Graduate examination of previous year of the concerned subject as invitee members for discussions on framing or revision of syllabus of that subject or group of subjects for one year.

a) **Ms. Mohaddasah Patel** (undergraduate student 18-19) Email Id- mohaddasah.98@gmail.com ; Mobile no- 9833781878

b) **Ms. Divya Srivastava** (undergraduate student18-19) Email ID- divyasrivastav20@gmail.com ; Mobile no- 8879240305

Part –I

Outline of Choice Based Credit System as outlined by University Grants Commission:

R. ** : The Definitions Of The Key Terms Used In The Choice Based Credit System And Grading System Introduced From TheAcademicYear2020-2021AreAs Under:**

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a core course.

2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   2.1 **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

   2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of adiscipline specific elective paper.

   2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
   P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Choice Base Credit System :** CBCS allows students to choose inter-disciplinary, intra-disciplinary courses, skill oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for students.

4. **Honours Program :** To enhance employability and entrepreneurship abilities among the learners, through aligning Inter Disciplinary / Intra Disciplinary courses with Degree Program. Honours Program will have
40 additional credits to be undertaken by the learner across three years essentially in Inter / Intra Disciplinary course.

   A learner who joins Regular Undergraduate Program will have to opt for Honours Program in the first year of the Program. However, the credits for honours, though divided across three years can be completed within three years to become eligible for award of honours Degree.

5. **Program:** A Program is a set of course that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study, B.Sc. Programs.

6. **Course:** A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e. there must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.

7. **Bridge Course:** Bridge course is visualized as Pre semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.

8. **Module and Unit:** A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.

9. **Self-Learning: 20% of the topics will be marked for Self-Learning.** Topics for Self-Learning are to be learned independently by the student, in a time-bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

   Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course. Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the students' learning achieved

in the topics earmarked for Self-Learning.

The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the students, in the course of the Self-Learning process.

The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and Peer learning. Groups can be formed to present self-learning topics to peer groups, followed by Question and Answer sessions and open discussion. The marking scheme for Self Learning will be defined under Examination and Teaching.

The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders preferably before the commencement of a semester. Some exceptions may be made inexigencies, like the current situation arising from the lockdown, but such ad hoc decisions are tobe kept to the minimum possible.

10. **Credit Point:** Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counseling sessions, watching especially prepared videos, writing assignments, preparing for examinations, etc. Credits assigned for a single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1 credit is construed as corresponding to approximately 30 to 40 learning hours.

11. **Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes successfully more and more courses. Thus the learner 'accumulates' course wise credits.

12. **Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically

updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.

13. **Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having some common courses and Performance transfer is said to have taken place.

14. **Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from 'relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

Part-II

O*** The fees for transfer of credits or performance will be based on number of credits that a learner has to complete for award of the degree.**

The Scheme of Teaching and Examination:

The performance of the learners shall be evaluated in two components: Internal Assessment with 40% marks by way of continuous evaluation and by Semester End Examination with 60% marks by conducting the theory examination.

INTERNAL ASSESSMENT:- It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

A). Internal Assessment – 40% **40 marks**

Practical's (internal Components of the Practical Course)

1. For Theory Courses

Sr. No.	Particulars	Marks
1	ONE class test / online examination to be conducted in the given semester	15 Marks
2	One assignment based on curriculum (to be assessed by the teacher Concerned	10 Marks
3	Self-Learning Evaluation	10 Marks
4	Active participation in routine class instructional deliveries	05 Marks

2. For Courses with Practicals

Each practical course can be conducted out of 50 marks with 20 marks for internal and 30 marks for external

Practical's (Internal component of the Practical Course)

Sr. No	Evaluation type	Marks
1	Two Best Practicals /Assignments/Presentation /Preparation of models/ Exhibits **Or** One Assignment/ project/presentation to be assessed by teacher concerned	10
2	Journal	05
3	Viva	05

The semester end examination (external component) of 60 % for each course will be as follows:

i) **Duration** – **2 Hours** ii) **Theory Question**

Paper Pattern:-

1. There shall be four questions each of 15 marks. On each unit there will be one question and the fourth one will be based on entire syllabus.
2. All questions shall be compulsory with internal choice within the questions. (Each question will be of 20 to 23 marks with options.)
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depend on the weightage of the topic.

The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

3. Project and Assignment:

- Project or Assignment, which can in the following forms
  - Case Studies
  - Videos
  - Blogs
  - Research paper (Presented in Seminar/Conference)
  - Field Visit Report
  - Presentations related to the subject (Moot Court, Youth Parliament, etc.)
  - Internships (Exposition of theory into practice)
  - Open Book Test
  - any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

4.Self-Learning Evaluation

- **20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE STUDENT THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURSE SPECIFIED IN THE CURRICULUM.**

- **HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF STUDENTS ON SELF LEARNING TOPICS**

- The identified topics in the syllabus shall be learnt independently by the students in a time bound manner preferably from online resources. Evaluative sessions shall be conducted by the teachers and will carry 10 Marks.

  CLUB The self-learning topics into 3-4 GROUPS OF TOPICS ONLY FOR EVALUATION.

- **PRESCRIBE TIME DURATION (IN DAYS) FOR COMPLETION OF EACH GROUP OF TOPIC AND EARMARK SELF LEARNING EVALUATION LECTURES IN THE TIMETABLE. HENCE EACH GROUP OF TOPIC CAN BE ASSIGNED 3 REGULAR LECTURES FOR THIS EVALUATION FOR ENTIRE CLASS**

3 Sub Topics

Each evaluative session shall carry 3 Marks (3 x 3 Units = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark.

4 Sub Topics

Each evaluative session shall carry 2.5 Marks (2.5 x 4 Units = 10 Marks)

- **EVALUATION OF SELF LEARNING TOPICS CAN COMMENCE IN REGULAR LECTURES ASSIGNED FOR SELF LEARNING EVALUATION IN THE TIMETABLE**

3 Evaluative sessions

Each evaluative session shall carry 3 Marks (3 x 3 = 9 Marks).
Students who participate in all evaluative sessions shall be awarded 1 additional Mark.

4 Evaluative sessions

Each evaluative session shall carry 2.5 Marks (2.5 x 4 = 10

Marks). <u>Methods for Evaluation of Self-learning topics:</u>

- Seminars/presentation (PPT or poster), followed by Q&A – Objective questions /Quiz / Framing of MCQ questions.
- Debates
- Group discussion
- You-Tube videos (Marks shall be based on the quality and viewership)
- Improvisation of videos
- Role Play followed by question-answers

TEACHERS CAN FRAME OTHER METHODS OF EVALUATION ALSO PROVIDED THAT THE METHOD, DULY APPROVED BY THE COLLEGE EXAMINATION COMMITTEE, IS NOTIFIED TO THE STUDENTS AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION AND IS FORWARDED FOR INFORMATION AND NECESSARY ACTION AT LEAT 3 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION

- Viva Voce
- Any other innovative method

SEMESTER END EXAMINATION: - It is defined as the examination of the learners on the basis of performance in the semester end theory / written examinations.

B. Semester End Examination- 60 % ***60 Marks***

1) Duration – These examinations shall be of 2 Hours duration.
2) Question Paper Pattern: -
   i. There shall be four questions each of 15 marks.
   ii. All questions shall be compulsory with internal choice within the questions.
   iii. Question may be sub-divided into sub-questions a, b, c, d & e only and the allocation of marks depends on the weightage of the topic.

THE MARKS OF THE INTERNAL ASSESSMENT SHOULD NOT BE DISCLOSED TO THE STUDENTS TILL THE RESULTS OF THE CORRESPONDING SEMESTER IS DECLARED.

HSNC University Mumbai

(2021-2022)

Ordinances and Regulations

With Respect to

Choice Based Credit System

(CBCS)

For the Programmes Under

The Faculty of Science and Technology

For the Course

Statistics

Curriculum – Second Year Undergraduate

Programmes Semester-III and Semester -IV

2021-2022

Statistics
Part 1- Preamble

B. Sc. Statistics program is of minimum 120 credits cover six semesters. Statistics is the language of the uncertainties riddled modern information age. Statistics facilitates the choice making process by quantifying the element of chance or uncertainties. It's descriptive and inferential roles not only formulate the basis of the expansion of almost all the disciplines of the modern world, but also provide an array of non-traditional employment avenues starting from that of sport analysts to business analysts to actuaries. The thrust of the course is to prepare students to enter into a promising career even after graduation, as also provide to them a platform for pursuing higher studies resulting in post-graduate or doctorate degrees. The program has some unique features like number of elective courses and extensive computer training of statistical computations including standard software packages like SPSS, SAS, MINITAB, R and PYTHON.

1. **Course objective:** The main objectives of the course are-

- Make students realize about understanding and importance of the data
- Acquaint students in understanding behaviour of the data
- Make students realize measuring certainty involved into uncertainty in happening of events with accuracy and precision
- Acquaint students in understanding behaviour of the data using discrete probability distributions and continuous probability distributions.
- Make students realize about understanding and importance of the Null hypothesis , Alternative Hypothesis and Large sample Tests
- Develop an understanding and application of statistical concepts and skills in the sciences and social sciences

Semester 3

Course Code: US-FST-301

Objective:

1) To understand the patterns in the data of large populations.
2) To obtain the central location, dispersion Moment Generating Distribution, Cumulant Generating Function and Characteristics Function of the discrete data manually and with MS Excel.
3) To know the relationship between various discrete distributions.

Course Code: US-FST-302

Objective:

1) To understand various sampling techniques like Simple Random Sampling, Stratified Sampling, Ratio and Regression etc.
2) To apply these techniques in real life situation.
3) Comparison of these sampling techniques.

Course Code: US-FST-303

Objective:

1) To increase in the awareness of quality among the customers and business competition at global level, it is quite essential to introduce the sophisticated techniques to improve the holistic quality up to the bench mark of the organization.
2) To focuses on providing a thorough knowledge of the Quality Management methodology to improve the quality of the process of the organization by minimizing the variation in the process.
3) To familiarize with statistical tools and exposed to specially designed software like MS EXCEL add-in Mega Stat

Semester 4

Course Code: US-FST-401

Objective:

1) To understand the patterns in the data of large populations.
2) To obtain the central location, dispersion Moment Generating Distribution, Cumulant Generating Function and Characteristics Function of the Continuous data.
3) To know the computation of probabilities, pdf, cdf using specially designed software like MS EXCEL add-in MegaStat.
4) To know the relationship between various continuous distributions.
5) To understand applications of t, F and Chi-Square Distributions in research; manually and using specially designed software like MS EXCEL add-in MegaStat.

Course Code: US-FST-402

Objective:

1) To introduce and apply the techniques and methodology available for designing and analysis of experiment.
2) To emphasize the need for sound and unambiguous interpretation of experimentation using Statistical Softwares like MS Excel and/or IBM SPSS Statistics.

Course Code: US-FST-403

Objective:

1) To Learn Statistical Software IBM SPSS Statistics.
2) To learn Data Entry, Data Manipulation to processing, Data Analysis for large data sets.
3) To learn to make course focused projects and preparation of reports.

2. Process adopted for curriculum designing.

The members of Department of Statistics initially drafted the syllabus. The draft syllabus was shown to Industry Partners, Academic Partners and Research Institute Partners through mail and in person invited to college. They suggested some changes. These changes were incorporated.

3. Salient features, how it has been made more relevant.

Statistics deals with collection, organization, analysis and interpretation of data. Statistical knowledge is very important as it helps to use appropriate methodologies for collecting data, tools for employing analysis and interpretation of results. It also provides us with techniques which are important in designing and planning of experiments.

A lot of data is generated at each and every moment. Data literacy has become crucial and indispensable to the society. Statistics has the quality of quantifying and measuring uncertainty which helps in assessing risk. It helps in extracting the meaningful information from the data, making predictions and taking decisions. Study of data has become an integral part of education, business, and overall human progress.

This has put Statistics on the center stage of teaching, research, policy making and development all over the globe.

The S.Y.B.Sc Statistics syllabus (SSTATS) is a Choice based credit system comprising of three papers having three units each in both the semesters.

The current course is designed to enhance the knowledge of the subject. While designing of the syllabus care has been taken to balance the fundamental techniques of Statistics with soft skills like analysis using **Statistical Softwares** MS-Excel and IBM SPSS Statistics (and remaining will be introduced phase wise at T.Y.B.Sc. level).

The course would give the students option to develop skills in areas which have direct relevance to employability in insurance and finance industries, banks, econometrics, quality control, pharmaceutical, medical statistics, agricultural statistics, weather forecasting, civil services, stock market, machine learning and artificial intelligence related job opportunities in Statistics.

4. Learning Outcomes

Our curriculum is designed to educate the learner about various applications of Statistics in various fields like Genetics, Medical Sciences, Pharmaceutical Industry, Environmental, Biotechnology, etc. The course would help students to apply their statistical concepts to summarize, analyze, and inculcate problem solving approach in the newer developments and innovations in the future. The curriculum design and the teaching and the evaluation patterns would help students to develop skills and competencies to build a progressive and successful career in the field of Statistics and Data Science.

- The learner will understand the importance of the data
- The learner will get acquainted with understanding behaviour of the data and pattern recognition.
- The learner will learn measuring certainty involved into uncertainty in happening of events with accuracy and precision
- The learner will understand behaviour of the data using discrete and continuous probability distributions.
- The learner will learn the handling of various softwares which will help them to acquaint with requisite skill which in turn will prepare them to secure high paid job in the industries.
- The learner will learn application of statistical concepts and skills in the sciences, management, commerce, social sciences and research.

Part 2- The Scheme of Teaching and Examination is as under:
Second Year Semester – III Summary

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (**Statistics**)			US-SST-301, US-SST-302, US-SSTP-3	
2	Elective Course	Discipline Specific Elective (DSE) Course			
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)			US-SST-303	
	Skill Enhancement Courses (SEC)				

Detail Scheme

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SE E	
1	US-SST-301	Probability Distributions	3	20% *	3	0	0	2	10	20	10	60	100
2	US-SST-302	Theory of Sampling	3	20% *	3	0	0	2	10	20	10	60	100
3	US-SST-303	Quality Management	3	20% *	3	0	0	2	10	20	10	60	100
4	US-SSTP-3	**Practical based on** MS-SST-301					3	1			10 (J+V)	40	50
		Practical based on MS-SST-302					3	1			10 (J+V)	40	50
		Practical based on MS-SST-303					3	1			10 (J+V)	40	50
	Total Hours / Credit							9	Total Marks				450

***One to two lectures to be taken for CONTINUOUS self -learning evaluation.**

Second Year Semester – III Units – Topics – Teaching Hours

S. N	Subject Code	Subject Unit Title		Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-SST-301	I	Univariate Random Variables. (Discrete and Continuous)	15	45L	2	100 (60+40)
		II	Standard Discrete Probability Distributions.	15			
		III	Bivariate Probability Distributions.	15			
2	US-SST-302	I	Concepts of Sampling and Simple Random Sampling.	15	45L	2	100 (60+40)
		II	Stratified Sampling.	15			
		III	Ratio and Regression Estimation.	15			
3	US-SST-303	I	Quality	15	45 L	2	100 (60+40)
		II	Quality Management	15			
		III	Statistical Quality Control	15			
4	US-SSTP-3	I	Practical based on US-SST-301	45	135 L	1	50
		II	Practical based on US-SST-302	45		1	50
		III	Practical based on US-SST-303	45			50
			TOTAL			24	600

- **Lecture Duration – 48 Minutes**
- **One Credit =15 Classroom hours**
- *First Batch Size of 25 students *** Second Batch of 20 Students * Last Batch of 20 Students**

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination , PA- Project Assessment, AT- Attendance

Part -3 - Detailed Scheme Theory

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

Course Code: US-SST-301
Title of Paper: Probability Distributions

Unit	Content	No. of Lectures
I	**Univariate Random Variables (Discrete and Continuous)** **1.1 Moment Generating Function(M.G.F.):** Definition, Properties:- Effect of change of origin and scale, M.G.F of sum of two independent random variables X and Y, Extension of this property for n independent random variables and for n i.i.d. random variables, All above properties with proof, Uniqueness Property without proof, Raw moments using M.G.F: using expansion method and using derivative method. **1.2 Cumulant generating Function(C.G.F.):** Definition, Properties:- Effect of change of origin and scale ,Additive Property of C.G.F., Both properties with proof, Obtaining Cumulants using C..G.F., Derivation of relationship between moments and cumulants upto order four. 1.3 **Characteristic Function:** Definition and properties (without Proof) Examples of obtaining raw moments and central moments up to order four using M.G.F. and C.G.F. for continuous and discrete distributions. 1.4 **Degenerate Distribution:** (One point distribution) P (X = c) = 1 Mean, Variance. **1.5 Discrete Uniform distribution:** Mean, Variance, coefficient of skewness using m.g.f. **1.6 Bernoulli distribution** Mean, Variance, coefficient of skewness using m.g.f. 1.7 **Binomial distribution** : Mean, Variance, Measures of skewness and Kurtosis based on moments using M.G.F. and C.G.F. , Nature of probability distribution with change in the value of parameter , Mode, Additive property , If X follows Binomial, then to find distribution of n - X. 1.8 Recurrence relation for moments with proof: $\mu'_{r+1} = np\mu'_r + \frac{d}{dp}\mu'_r$ $\mu_{r+1} = pq[nr\mu_r + \frac{d}{dp}\mu_r]$ 1.9 Fitting of Binomial Distribution, Relation between Bernoulli and Binomial using m.g.f.	15
II	**Standard Discrete Probability Distributions** **2.1 Poisson Distribution:** Mean, Variance, Measures of skewness and Kurtosis based on moments using M.G.F. and C.G.F., Nature of probability distribution with change in the value of parameter, Mode, Additive property, Recurrence relation for moments with proof for μ'_{r+1} & μ_{r+1}, If X and Y are two independent Poisson variables Conditional distribution of X given X+Y (with proof), Poisson distribution as limiting distribution of Binomial (with proof),Real life examples of Binomial, Poisson distribution, Fitting of Poisson Distribution. **2.2 Geometric Distribution:**	**15**

	Definition in terms of No. of failures and No. of trials, Mean, Variance. M.G.F., Mean and Variance using M.G.F., C.G.F., Mean, Variance, μ_3, μ_4 using C.G.F. Coefficients of skewness and Kurtosis and Nature of probability distribution with change in the value of parameter, Property of Lack of Memory (with proof) , If X and Y are two i.i.d. Geometric variables; Conditional distribution of X given X+Y(with proof), Distribution of k i.i.d. Geometric variables. **2.3 Negative Binomial Distribution:** Definition, Mean, Variance. M.G.F., Mean and Variance using M.G.F., C.G.F., Mean, Variance, μ3, μ4 using C.G.F., Coefficients of skewness and Kurtosis and Nature of probability distribution with change in the value of parameter, Recurrence relation for probabilities, Fitting of distribution, Limiting distribution of Negative Binomial distribution (with proof) **2.4 Hyper-Geometric Distribution:** Definition, Mean, Variance, Limiting distribution of Hyper-Geometric distribution. If X and Y are two independent Binomial variables; Conditional distribution of X given X+Y 2.5 Real life situations of Geometric, Negative Binomial, Hyper-Geometric Distributions **2.6 Truncated Distributions:** Definition: Truncated Binomial and Truncated Poisson Distribution: probability mass function, mean and variance.(truncated at 0)	
III	**Bivariate Probability Distributions** 3.1 **Two Dimensional Discrete Random Variables:** Joint Probability mass function and its properties, Distribution function of (X, Y)and its properties, Definition of raw and central moments, covariance, correlation coefficient, Independence and correlation between two variables, Marginal and conditional probability distributions, Conditional expectation, conditional variance 3.2 **Continuous Bivariate Random Variables:** Joint Probability density function and its properties, Distribution function of (X, Y)and its properties, Definition of raw and central moments, covariance, correlation coefficient, Independence and correlation between two variables, Marginal and conditional probability distributions, Conditional expectation, conditional variance, Regression Function. **3.3 Transformation of discrete & continuous random variables.**	**15**

Self-Learning topics (Unit wise)

Unit	Topics
1.7	Binomial Distribution: Additive Property
2.1	Poisson Distribution: Additive Property
2.2	**Geometric Distribution:** Distribution of k i.i.d. Geometric variables
2.3	**Negative Binomial Distribution:**Definition, Mean, Variance
3.1	Joint Probability mass function and its properties, Distribution function of (X, Y)and its properties
3.2	Joint Probability density function and its properties, Distribution function of (X, Y) and its properties
3.3	**Transformation of discrete & continuous random variables**

Online Resources

"Probability and Statistics" by Prof. Somesh Kumar, Department of Mathematics, IIT Kharagpur Source : https://nptel.ac.in/courses/111/105/111105090/ on unit 3.3

Course Code: US-SST-302
Title of Paper: Theory of Sampling

Unit	Content	No. of Lectures
I	Concepts of Sampling and Simple Random Sampling. 1.1 Concept of sampling : Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiased Estimator, Mean square error & Standard error. Census Survey, Sample Survey. Steps in conducting sample survey with examples on designing appropriate Questionnaire. Concepts of Sampling and Non-sampling errors. Concepts and methods of Probability and Non Probability Sampling. 1.2 Simple Random Sampling (SRS) : Definition, Sampling with & without replacement (WR/WOR). Lottery method & use of Random numbers to select simple random sample. Estimation of population mean & total. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators (WR/WOR). 1.3 Estimation of population proportion. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators (WR/WOR). 1.4 Estimation of sample size based on a desired accuracy in case of SRS for variables & attributes (WR/WOR)	15
II	2.1 Stratified Sampling: Need for Stratification of population with suitable examples. Definition of Stratified Sample. Advantages of Stratified Sampling. 2.2 Estimation of population Mean and Total in case of Stratified Random Sampling (WOR within each strata). Expectation and Variance of the unbiased estimators, Unbiased estimators of variances of these estimators, Proportional allocation, Optimum allocation with and without varying costs. 2.3 Comparison of Simple Random Sampling, Stratified Random Sampling using Proportional allocation and Neyman allocation.	15
III	3.1 Ratio and Regression Estimation Ratio & Regression Estimation Method assuming SRSWOR Ratio Estimators for population Ratio, Mean and Total. Expectation & MSE of the Estimators. Estimators of MSE. Uses of Ratio Estimator. 3.2 Regression Estimators for population Mean and Total. Expectation and Variance of the Estimators assuming known value of regression coefficient 'b'. Estimation of 'b'. Resulting variance of the estimators. Uses of regression Estimator. Comparison of Ratio, Regression & mean per unit estimators. 3.3 Introduction to different methods of sampling: Introduction to Systematic sampling, Cluster sampling and Two stage sampling with suitable illustrations. Comparing various Sampling Methods.	15

Self-Learning topics (Unit wise)

Unit	Topics
1.1	Census Survey, Sample Survey. Steps in conducting sample survey with examples on designing appropriate Questionnaire.

1.4	Estimation of sample size based on a desired accuracy in case of SRS for variables
2.1	Need for Stratification of population with suitable examples. Definition of Stratified Sample. Advantages of Stratified Sampling.
3.1	Ratio Estimators for population Ratio, Mean and Total. Expectation & MSE of the Estimators
3.3	Introduction to Systematic sampling, Cluster sampling with suitable illustrations. Comparing various Sampling Methods.

Online Resources

'Business Statistics' by PROF. M. K. BARUA, Department of Management Studies, IIT Roorkee, available on the NPTEL portal **https://nptel.ac.in/courses/110/107/110107114/# for 2.1**
"Sampling Theory" **Swayam Prabha Course, Channel 16, MOE, GOI by Prof. Shalabh, IIT Kanpur** Source: https://www.youtube.com/playlist?list=PLqMl6r3x6BUTP4XPysDab-RrLAt4_PP6E for units 1.4, 2.1, 3.1, 3.3

Course Code: US-SST-303

Title of paper: Quality Management

Unit	Content	No. of Lectures
I	**Quality** 1.1 American Society for Quality (ASQ) , Quality Society of Australia(QSA) and Re Accreditation Board(RAB USA). Brief idea of quality, Introduction to Lean : Definition of Lean , 5 S in Lean, The 5 Principles of Lean,7 Wastes in Lean . 1.2 Six – Sigma: Definition of six-sigma, Meaning of Lean- six – sigma 1.3 Six – sigma methodology: Over view of DMAIC. 1.4 Define Phase : VOC,VOP,VOB,CTQ,COPQ, Process map, Problem statement , Goal statement ,Project charter, SIPOC, Brain storming, 1.5 Negative brain storming	15
II	**Quality Management** 2.1 Measure phase :Measurement System Analysis, Accuracy , Precision, Repeatability, Reproducibility, Gage R & R ,Process performance. DPMO, DPU, Yield , Process Capability Analysis: Introduction to process capability, concept, Specification limits natural tolerance limits and their comparisions, estimate of percent defectives, Capability ratio and Capability indices (Cp), Capability performance indices Cpk with respect to machine and process interpretation, relationship between **(i) Cp and Cpk** **(ii) Defective parts per million and Cp.** 2.2 Analyse Phase : Basic statistics : Types of Data , Descriptive statistics correlation and simple linear regression, Residuals, R^2 , adjusted R^2, probability distributions. 2.3 Process Door and Data Door, Root cause analysis, 2.4 Graphs: Histogram, Box – plot, scatter plot , Pareto chart, Run chart, Cause and effect diagram. 2.5 Improve Phase : Multi Voting , Delphi Technique , Nominal Group Technique , Kaizen, SCAMPER.	15

III	**Statistical Quality Control** 3.1 Control Phase : Control plans , Poka Yoke 3.2 Statistical Process Control : Introduction, X – bar , R and IMR charts , P and nP charts, C and U charts. Chances of shift detection. 3.3 CASE STUDY 3.4 Natural Tolerance Limits and Specification Limits.	15

Self-Learning topics (Unit wise)

Unit	Topics
I	The 5 Principles of Lean, Negative brain storming
II	Process Capability Analysis, correlation and simple linear regression, Process Door and Data Door, : Histogram, SCAMPER
III	Statistical Process Control : Introduction

Online Resources

The 5 Principles of Lean ⟶ https://kissflow.com/project/agile/5-principles-of-lean/
Negative Brain storming ⟶ https://www.slideshare.net/guestf761cb/reverse-brainstorming-2154911
Process Capability Analysis ⟶ https://sixsigmastudyguide.com/process-capability-pp-ppk-cp-cpk/
Correlation and simple linear ⟶ https://www.bmj.com/about-bmj/resources-readers/publications/statistics-square-one/11-correlation-and-regression Regression
Process Door and Data Door ⟶ https://www.benchmarksixsigma.com/forum/topic/36217-process-door-vs-data-door/
Histogram ⟶ **https://asq.org/quality-resources/histogram**
SCAMPER ⟶ https://youtu.be/G8w0rJhztJ4 https://youtu.be/vqnIEtlp9d8
"Quality Control and Improvement With Minitab: by Prof. Indrajit Mukherjee, Management, IIT Bombay, Source:**https://nptel.ac.in/courses/110/101/110101150/** for unit 2(PCA) and unit 3

Part – 4- Detailed Scheme Practical

US-SSTP-3

Practical of Semester III Total Credit: 03

Paper Code	Title	No. of Lectures
US-SSTP-301	1. Moment Generating Function, Moments. 2. Cumulant generating Function and Characteristic function. 3. Standard Discrete Distributions 4. Fitting Standard Discrete Distributions 5. Bivariate Probability Distributions 6. Transformation of discrete & continuous random variables 7. Plotting of pmf, cdf, computation of probability and fitting of distribution using MS-Excel	03 Lectures per Practical per Batch*
US-SSTP-302	1. Designing of Questionnaire. 2. Simple Random Sampling for Variables 3. Simple Random Sampling for Attributes 4. Estimation of Sample Size in Simple Random Sampling 5. Stratified Random Sampling. 6. Ratio and Regression Estimation	
US-SSTP-303	1. Graphs and Diagram 2. Analyse Phase: Descriptive Statistics 3. Improve Phase tools 4. Control Charts for Attributes 5. Control Chart for Variables 6. Process Capability Analysis and Process Shift	

*** All practical will be based on the real life/ raw online website data as well as finished data which are analysed using Calculator, SPSS / Excel.**

References:

Course Code: US-SST-301

1) Introduction to the theory of statistics: A. M. Mood, F.A. Graybill, D. C. Boyes, Third Edition; McGraw-Hill Book Company.
2) Introduction to Mathematical Statistics: R.V.Hogg, A.T. Craig; Fourth Edition;Collier McMillan Publishers.
3) Probability and Statistical Inference: R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.
4) John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.
5) Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.
6) Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.
7) Mathematical Statistics: J.N. Kapur, H.C. Saxena; Fifteenth Edition; S. Chand & Company Ltd.
8) Statistical Methods: An Introductory Text: J. Medhi; Second edition; Wiley Eastern Ltd.
9) An outline of statistical theory Vol. I: A.M Goon, M. K. Gupta, B. Das Gupta: Third Edition: The World Press Pvt. Ltd.

Course Code: US-SST-302

1. Sampling Techniques: W.G. Cochran; 3rd Edition; Wiley(1978)
2. Sampling Theory and methods: M.N. Murthy; Statistical Publishing Society. (1967)
3. Sampling Theory: Des Raj; McGraw Hill Series in Probability and Statistics. (1968).
4. Sampling Theory of Surveys with Applications: P.V. Sukhatme and B.V. Sukhatme; 3rd Edition; Iowa State University Press (1984).
5. Fundamentals of Applied Statistics: S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
6. Theory and Analysis of Sample Survey Designs: Daroga Singh, F.S.Chaudhary, Wiley Eastern Ltd. (1986).
7. Sampling Theory and Methods: S. Sampath, Second Edition (2005),Narosa.
8. Theory and Methods of Survey Sampling: Parimal Mukhopadhyay, (1998), Prentice Hall Of India Pvt. Ltd.

Course Code: US-SST-303

1. Lean Six-sigma for Dummies by John Morgan & Martin Brenig - Jones
2. The Lean Six – sigma Pocket Tool book by Michael L. George
3. Statistics for Six- sigma Black Belt by Matthew Barsalou
4. The ASQ auditing handbook : principles, implementation, and use by https://www.pdfdrive.com/the-asq-auditing-handbook-principles-implementation-and-use-e166861213.html

Part 5- The Scheme of Teaching and Examination is as under:
Second Year Semester – IV Summary

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (**Statistics**)			US-SST-401, US-SST-402, US-SSTP-4	
2	Elective Course	Discipline Specific Elective (DSE) Course			
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)			US-SST-403	
	Skill Enhancement Courses (SEC)				

Detail Scheme

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Tot al Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SEE	
1	US-SST-401	Probability and Sampling Distribution	3	20% *	3	0	0	2	10	20	10	60	100
2	US-SST-402	Analysis of Variance & Design of Experiments	3	20% *	3	0	0	2	10	20	10	60	100
3	US-SST-403	Exploratory Data Analysis using SPSS	3	20% *	3	0	0	2	10	20	10	60	100
4	US-SSTP-4	**Practical based on** US-SST-401					3	1			10 (J+V)	40	50
		Practical based on US-SST-402					3	1			10 (J+V)	40	50
		Statistical Course based Project					3	1			10 (J+V)	40	50
	Total Hours / Credit							9	Total Marks				600

***One to two lectures to be taken for CONTINUOUS self -learning evaluation.**

Second Year Semester – IV Units – Topics – Teaching Hours

S. N	Subject Code	Subject Unit Title		Hours /Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-SST-401	I	Standard Continuous Probability Distributions	15	45L	2	100 (60+40)
		II	Normal Distribution	15			
		III	Exact Sampling Distributions	15			
2	US-SST-402	I	Analysis Of Variance	15	45L	2	100 (60+40)
		II	Design of Experiments	15			
		III	Latin Square Design and Factorial Experiment	15			
3	US-SST-403	I	Managing Data	15	45 L	2	100 (60+40)
		II	Descriptive Statistics and Reliability	15			
		III	Non-parametric tests and Multi-Dimensional Scaling (MDS) & Correspondence Analysis	15			
4	US-SSTP-4	I	Practical based on US-SST-401	45	135 L	1	50
		II	Practical based on US-SST-402	45		1	50
		III	Statistical Course based Project	45		1	50
			TOTAL			9	600

- **Lecture Duration – 48 Minutes**
- **One Credit =15 Classroom hours**

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination , PA- Project Assessment, AT- Attendance

Part -6 - Detailed Scheme Theory

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

Course Code: US-SST-401

Title of Paper: Probability and Sampling Distributions

Unit	Content	No. of Lectures
1	**Standard Continuous Probability Distributions** 1.1 **Rectangular or Continuous Uniform** over (a,b). Mean, Median Standard deviation, C.D.F.,M.G.F., Mean ,variance, μ3 using M.G.F., skewness of distribution, Fitting of Rectangular Distribution. For X following U (0,1), distribution of i) $(\frac{X}{1+X})$, ii) $(\frac{X}{1-X})$ **1.2 Triangular Distribution :** Triangular distribution over(a,b) with peak at c , M.G.F. **1.3 Exponential Distribution (Single parameter)** Definition, M.G.F.,C.G.F. raw moments and central moments upto order four using M.G.F..and C.G.F. , Measures of Skewness and Kurtosis ,Nature of Probability curve, Median and Quartiles, Forgetfulness Property with proof and examples based on it, Distribution of ratio of two i.i.d. Exponential variables, Distribution of X+Y and $\frac{X}{X+Y}$,for two independent Exponential variables X and Y with mean(1). (All with proof.), Fitting of Exponential Distribution. **1.4 Cauchy (with location and scale parameter):** -Properties without proof **1.5 Gamma (with scale and shape parameter):** Expression for r th raw moment, Mean, Mode & Standard deviation. M.G.F., Additive property, C.G.F., raw moments and central moments upto order four using M.G.F. and C.G.F. Coefficient of skewness and kurtosis and nature of probability curve. 1.6 Distribution of sum of independent Exponential variables, **1.7 Beta Distribution: Type I & Type II:** Expression for r th raw moment, Mean, Mode Standard deviation. If a r.v. X follows Beta of type 1, distribution of 1- X If a r.v. X follows Beta of type 2, distribution of i) $)\frac{1}{1+X}$, ii) $\frac{X}{1+X}$ (with proof). 1.8 For two independent Gamma variables X and Y with parameters m and n respectively, distribution of U = $\frac{X}{Y}$ and V= -$\frac{X}{X+Y}$ (with proof).	15
2	**Normal Distribution** 2.1 **Normal Distribution** : Definition, Derivation of Mean, Median, Mode, Standard deviation, M.G.F. , C,G,F., Moments & Cumulants (up to fourth order). skewness & kurtosis, Nature of Normal curve, Mean absolute deviation. 2.2 Properties of Normal Distribution. 2.3 Expression for even order central moments and to show that odd order central moments zero. **2.4 Distribution of Standard Normal Variable** 2.5 **Distribution of linear function of independent Normal var**iables (i) aX, (ii) X+b, (iii) aX+bY in particular X+Y and X-Y, (iv) aX+bY+c (all with proof.) 2.6 Fitting of Normal Distribution. 2.7 Central Limit theorem for i.i.d. random variables.(only statement)	**15**

	2.8 **Log Normal Distribution:** Derivation of mean & variance.	
3	**Exact Sampling Distributions** 3.1 Chi-Square Distribution: a. Derivation of p.d.f. Mean, Mode & Standard deviation, M.G.F.,C.G.F., Measures of skewness and kurtosis, Additive property b. Distribution of ratio two independent Chi-square variables c. Distribution of $\frac{X}{X+Y}$ if X and Y two independent Chi-square variables (All with proof) 3.2 Distribution of the sum of squares of independent Standard Normal variables. 3.3 Sampling distributions of sample mean and sample variance and their independence for a sample drawn from Normal distribution (without proof). 3.4 **Applications of Chi-Square**: a. Development of decision criterion with test procedures of b. (i)Test of significance for specified value of variance of a Normal population (ii)Test for goodness of fit, c. Test Procedure for independence of attributes. (i) rxc contingency table, (ii) 2x2 contingency table, Derivation of test statistic, Yate's correction with proof d. Derivation of Confidence interval for the variance of a Normal population when (i) mean is known, (ii) mean is unknown **3.5 Student t-distribution:** Derivation of p.d.f. , Mean, variance, rth order raw moment, Mean Deviation, Measures of skewness and Kurtosis and Additive property. Limiting distribution of t distribution with proof. **3.6 Applications of t distribution:** Development of decision criterion with test procedure of Test of significance for specified value of mean of Normal population. **3.7 Test procedure of test of significance for difference between means of** i. two independent Normal populations with equal variances ii. Dependent samples (Paired t test) **3.8 Derivation of Confidence intervals for** i. Mean of Normal population, ii. difference between means of two independent Normal populations having the same variance. **3.9 Snedecor's F-distribution:** Derivation of p.d.f. , Expression for r th raw moment, Mean, Mode & Standard Deviation, Distribution of Reciprocal of F variable with proof. 3.10 **Applications of F distribution:** **3.11 Test procedure for testing equality of variances of two independent Normal populations** i. Mean is known ii. Mean is unknown 3.12 Derivation of confidence interval for ratio of variances of two independent Normal populations.	**15**

Self-Learning topics (Unit wise)

Unit	Topics
1.3	Exponential Distribution: Forgetfulness Property with proof and examples based on it.
2.1	Expression for even order central moments and to show that odd order central moments zero for Normal distribution
2.2	**Distribution of Standard Normal Variable**

3.1	Chi-Square Distribution: Derivation of p.d.f. Mean, Mode & Standard deviation
3.5	**Student t-distribution** :Derivation of p.d.f. , Mean, variance, rth order raw moment, Mean Deviation, Measures of skewness and Kurtosis
3.9	F Distribution: Derivation of p.d.f. , Expression for r th raw moment, Mean, Mode & Standard Deviation, Distribution of Reciprocal of F variable with proof.

Online Resources

"Probability and Statistics" by Prof. Somesh Kumar, Department of Mathematics, IIT Kharagpur Source : https://nptel.ac.in/courses/111/105/111105090/ on unit 3.3.

Course Code: US-SST-402

Title of Paper: Analysis of Variance & Design of Experiments

Unit	Content	No. of Lectures
1	**Analysis of Variance :** 1.1 Introduction, Uses, Cochran's Theorem (Statement only). **1.2 One way classification with equal & unequal observations per class, Two way classification with one observation per cell:** Mathematical Model, Assumptions, Expectation of various sums of squares, F- test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard Error and Confidence limits for elementary treatment contrasts, 1.3 Introduction to Multiple Comparison Tests.	15
2	**Design Of Experiments :** **2.1 Introduction:** Concepts of Experiments, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. 2.2 **Principles of Design of Experiments:** Replication, Randomization & Local Control. Efficiency of design D1 with respect to design D2. Choice of size, shape of plots and blocks in agricultural & nonagricultural experiments. **2.3 Completely Randomized Design (CRD) and Randomized Block Design (RBD):** Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table, Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. 2.4 Efficiency of RBD relative to CRD.	15
3	**Latin Square Design and Factorial Experiments :** 3.1 **Latin Square Design:** 3.2 Basics in Latin Square Design, Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of the design relative to RBD, CRD. 3.3 **Missing Plot Technique** for one missing observation in case of CRD, RBD and LSD**.** **3.4 Factorial Experiments:** Definition, Purpose & Advantages. 2^2, 2^3 Experiments. Calculation of Main & interaction Effects. Definition of contrast and orthogonal contrast, Yates'	15

	method. Analysis of 2^2 & 2^3 factorial Experiments.	

Self-Learning topics (Unit wise)

Unit	Topics
1	Introduction to Multiple Comparison Tests.
2	Concepts of Experiments, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. Principles of Design of Experiments: Replication, Randomization & Local Control. Efficiency of design D1 with respect to design D2. Choice of size, shape of plots and blocks in agricultural & nonagricultural experiments
3	Basics in Latin Square Design , Factorial Experiments: Definition, Purpose & Advantages. 2^3 Experiments. Calculation of Main & interaction Effects. Definition of contrast and orthogonal contrast, Yates' method. Analysis of 2^3 factorial Experiments.

Online Resources

Analysis of Variance and Design of Experiments, Swayam Prabha Course, MOE, GOI by Prof. Shalabh, IIT Kanpur **http://home.iitk.ac.in/~shalab/spanova.htm?fbclid=IwAR3mmXTpm6P6BSnoaAX25qkyrLx9LGy5SXLj3CodHFYWwHrnL-5IKI5f6SI** for Unit 2 and 3.

Course Code: US-SST-403

Title of paper: Exploratory Data Analysis using SPSS

Unit	Content	No. of Lectures
1	**Managing Data in SPSS** 1.1 Creating and Editing Data File 1.2 Data Manipulation: Sorting Data, Merging and Appending Data/files, Aggregating/summarizing Data, Reshaping Data, Recording Variables, Sub setting Data, Data Type Conversions, Sampling, Renaming-formatting data, Handling duplicates/Missing values, Computing new variables, Selecting cases 1.3 Visualization for Univariate, Bivariate and Multivariate Data: Diagram Vs Graphs 1.4 Creating available Graphs, Histograms & Density Plot, Dot Plots – Bar Plots(Column, Subdivided, Percentage) – Line Charts – Pie Charts –Boxplots – Scatterplots	15
2	**Descriptive Statistics and Reliability Analysis** 2.1 Parametric Test Vs Non parametric Test 2.2 Frequencies: Frequencies , percentiles, OLAP Cubes 2.3 Descriptive Statistics: Measure of Central Tendancy, Variability, deviation from normality, size and stability, Normality Test 2.4 Crosstabulation and Chi Square Analyses, Cramer V, Phi, Fisher Exact Test, odds Ratio 2.5 Correlation : Bivariate Correlations, partial correlations, the correlation matrix 2.6 Simple Linear Regression 2.7 Parametric Test: The Mean Procedure 2.8 Reliability Analysis: Coefficient alpha and split half reliability	15
3	**Non-parametric tests and Multi-Dimensional Scaling (MDS) & Correspondence Analysis** 3.1 **Non-parametric tests for hypothesis testing**: Concept of Parametric Vs Nonparametric, Fisher's exact test, Wilcoxon	15

	signed rank test, Wilcoxon rank sum test, Mann-Whitney 'U' test, Kruskal-Wallis test, Friedman test. 3.2 **Multi-Dimensional Scaling (MDS) & Correspondence Analysis**: Objective of MDS, Comparing MDS to other interdependence techniques, Research design, Assumption of MDS, Deriving MDS & assessing over fit, Validating MDS, Objective of correspondence analysis., Research design, Assumptions of correspondence analysis, Deriving of CA & assessing overall fit, Case Study	

Self-Learning topics (Unit wise)

Unit	Topics
I	Formatting data, Handling duplicates/Missing values, Computing new variables, Selecting cases, Creating available Graphs, Histograms & Density Plot
II	Normality Test , Crosstabulation ,Correlation and Regression: Bivariate Correlations, Simple Linear Regression, Parametric and Test: The Mean (t-test and ANOVA) Procedure
III	Concept of Parametric V/S Nonparametric, Mann-Whitney 'U' test, Kruskal-Wallis test, Friedman test

Online Resources

'Marketting Research and Analysis-II' by PROF. J. K. NAYAK, Department of Management Studies, IIT Roorkee, available on the NPTEL portal, https://nptel.ac.in/courses/110/107/110107113/ for US-FAST- 402 for unit I, II and III.

Part – 7- Detailed Scheme Practical

Practical of Semester II — Total Credit: 08

Paper Code	Title	No. of Lectures
MS-SSTP-401	1. Standard Continuous distribution-I 2. Standard Continuous distribution-II 3. Standard Continuous distribution with Excel 4. Normal distribution 5. Central Limit Theorem 6. Chi Square Distribution 7. t Distribution 8. F Distribution	03 Lectures per Practical per Batch*
MS-SSTP-402	1. Analysis Of Variance- One Way Classification 2. Analysis Of Variance- Two Way Classification 3. Completely Randomized Design 4. Randomized Block Design 5. Latin Square Design 6. Missing Observation in CRD, RBD, and LSD. 7. Factorial Experiment	
MS-SSTP-403	Course focused Statistical Group Project having team of 4-5 Students.	

*** All practical will be based on the real life/ raw online website data as well as finished data which are analysed using Calculator, SPSS / Excel.**

*First Batch Size of 25 students * Second Batch of 20 Students * Last Batch of 20 Students

References:

Course Code: US-SST-401

1. Introduction to the theory of statistics: A M Mood, F.A. Graybill, D C Boyes; Third Edition; McGraw-Hill Book Company.
2. Introduction to Mathematical Statistics: R.V.Hogg, A.T. Craig; Fourth Edition; Collier McMillan Publishers.
3. Probability and Statistical Inference: R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.
4. John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.
5. Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.
6. Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.
7. Mathematical Statistics: J.N. Kapur, H.C. Saxena; Fifteenth Edition; S. Chand & Company Ltd.
8. Statistical Methods- An Introductory Text: J. Medhi; Second edition; Wiley Eastern Ltd.
9. An Outline of Statistical Theory Vol. 1: A.M. Goon, M.K. Gupta, B. DasGupta: Third Edition; The World Press Pvt. Ltd.

Course Code: US-SST-402

1. Experimental Designs: W.G. Cochran and G.M.Cox; Second Edition;John Wiley and Sons.
2. The Design and Analysis of Experiments: Oscar Kempthorne, John Wiley and Sons.
3. Design and Analysis of Experiments: Douglas C Montgomery; 6th Edition;John Wiley & Sons.
4. Design and Analysis of Experiments: M.N.Das and N.C.Giri, 2nd Edition; New Age International (P) Limited;1986.
5. Experimental Design, Theory and Application: Walter T Federer; Oxford & IBH Publishing Co. Pvt. Ltd.
6. Fundamentals of Applied Statistics: S.C.Gupta and V.K.Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
7. Statistical Principles in Experimental Design: B.J. Winer, McGraw Hill Book Company

Course Code: US-SST-403

1. SPSS for Windows Step by Step A Simple Guide and Reference by Darren George and Paul Mallery, Pearson
2. Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). SAGE Publications.
3. Brian C. Cronk, How to Use SPSS®: A Step-By-Step Guide to Analysis and Interpretation Paperback