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 of Department, 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 / writtenexaminations.

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 Postgraduate

Programmes Semester-III and Semester -IV

2021-2022

Statistics
Part 1- Preamble

M. Sc. Statistics program is of minimum 96 credits cover four 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. The program emphasizes both theory and modern applications of statistics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, in academics and other government and non-government organizations. The program has some unique features like independent projects, number of elective courses and extensive computer training of statistical computations including standard software packages like SPSS, SAS, MINITAB, R and PYTHON. Due to Cluster University, the department got the academic autonomy and it's been utilized to add the new and need based elective courses. The independent project work is one among the important components of this program. The syllabus of the first year (two semesters) covers most of the core courses. In the second year of the syllabus, there are six core courses, six optional courses and one project. The syllabus has been framed to possess a decent balance of theory, methods and applications of statistics. It is possible for the students to study basic courses from other disciplines like economics, life sciences, computer science and Information Technology in place of optional/electives. The thrust of the course is to prepare students to enter into a promising career after post graduation, as also provide to them a platform for pursuing higher studies resulting in doctorate degrees.

1. **Course Objective:** The main objectives of the course are-
   - 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 probability distributions.
   - To provide a systematic account of Neyman-Pearson, theory of testing and closely related theory of point estimation and confidence sets, together with their applications
   - Make students realize about understanding and importance of the data
   - Acquaint students in understanding behaviour of the data
   - Make students realize about understanding and importance of the Hypothesis and Statistical Sample Tests in decision drawing.
   - Develop an understanding and application of statistical concepts and skills in the sciences and social sciences.

   To think analytically, creatively and critically in developing robust, extensible and highly maintainable technological solutions to simple and complex problems related to human, technology and environmental factors.

Semester III

Course Code: MS-SST-301- Design of Experiments
Objective: To provide orientation of statistics while designing statistical experiments, particularly in agricultural set up and in pharmaceutical production processes. Exposure to numerous statistical designs resulting in the analysis of variance, eliminating heterogeneity of the data, construction of styles are provided.

Course Code: MS-SST-302- Time Series Analysis
Objective: Time series analysis is essential for choosing the right kinds of strategies (like descriptive, explanatory, forecasting, or control) to implement. In addition, the behavior of a time series by training models on its components is explained to learners. Forecasting, uses the observed values of a time series with a model to predict the future time series values. Several forecasting techniques like AR, ARIMA, SARIMA etc are discussed

Course Code: MS-SST-303- Categorical and Text Data Analysis
Objective: This course deals with the analysis of categorical data measured on different scales. Text

collection, text transformation to text mining is also discussed. The estimation and testing techniques associated with various advance models are discussed. Fitting of models and methods in model selection also are discussed.

Course Code: MS-SST-304- Applied Advance Multivariate Techniques
Objective: The objective of the course is to make the students conversant with various advance multivariate techniques like Meta-Analysis, Structural equation modeling, Naïve Bayes' classification and Market Basket Analysis used in summarization and analysis of data. The focus will be both on theoretical as well as practical approach using commonly used Statistical Software. The topics are quite helpful during industrial training/placements of M.Sc. Students.

Semester IV

Course Code: MS-SST-401- Nonparametric Inference
Objective: The objective of this course is to apprise the learners about various techniques of hypothesis testing when the assumptions of parametric tests aren't fulfilled. Thrust are going to be to study various non-parametric analogues to one, two and c-sample location problems in addition to two sample scale problems.

Course Code: MS-SST-402- Advance Inference
Objective: The objective of this paper is to acquaint students with the advanced applications of statistical inference along with the higher probability concepts. The course lays the background for the students to get familiar with the properties of various estimators used in inference.

Course Code: MS-SST-403- Survival Analysis
Objective: The course gives the application of statistics in handling survival data. The course introduces the concept of censoring and the various distributions used to analyse such data. Various models are also suggested to deal with survival data.

Course Code: MS-SST-404- Statistical Process Control
Objective: The paper shows the applications of Statistics to take care of quality in Engineering or industrial set up. the theory of control charts, sampling plans and process capability indices is the basis for judging whether the method is in statistical control or not. The topics are quite helpful during industrial training/placements of M.Sc. Students.

2. **Process adopted for curriculum designing.**

The department has conducted multiple meetings with academician, industry experts. After discussion with them, the changes in the syllabus were introduced with the view that students need to learn the core concepts in detail.

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

After discussion and interaction with the members of BOS and understanding the requirement of the industries certain changes in the syllabus are introduced. Seminars, Interaction with Industry Experts, Field Visits and upcoming technologies like Contingencies, FOSS R/ Python, Data Science etc. have been added keeping the upcoming trends in the field of Statistics.

4. **Learning Outcomes:**

It is expected to improvise the theoretical as well as application based soft skills for the students and make them Market ready for Jobs and Higher Research & Development.

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**)			MS-SST-301, MS-SST-302, MS-SSTP-301, MS-SSTP-302	
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)			MS-SST-304, MS-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	SEE	
1	MS-SST-301	Design of Experiments	4	20% *	4	0	0	4	10	20	10	60	100
2	MS-SST-302	Time Series Analysis	4	20% *	4	0	0	4	10	20	10	60	100
3	MS-SST-303	Categorical and Text Data Analysis	4	20% *	4	0	0	4	10	20	10	60	100
4	MS-SST-304	Applied Advance Multivariate Techniques	4	20% *	4	0	0	4	10	20	10	60	100
5	MS-SSTP-301	**Practical based on** MS-SST-301					2	2			10 (J+V)	40	50
6	MS-SSTP-302	**Practical based on** MS-SST-302					2	2			10 (J+V)	40	50
7	MS-SSTP-303	**Practical based on** MS-SST-303					2	2			10 (J+V)	40	50
8	MS-SSTP-304	**Practical based on** MS-SST-304					2	2			10 (J+V)	40	50
	Total Hours / Credit							24	Total Marks				600

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

First Year Semester – II Units – Topics – Teaching Hours

S.N	Subject Code	Subject Unit Title		Hours /Lectures	Total No. of hours/lectures	Credit	Tot al Marks
1	MS-SST-301	I	Design of Experiment	15	60 H	4	100 (60+40)
		II	Factorial Experiments I	15			
		III	Factorial Experiments II	15			
		IV	Response Surface Methods:	15			
2	MS-SST-302	I	Introduction	15	60 H	4	100 (60+40)
		II	Time Series Formulation	15			
		III	Time Series Models I	15			
		IV	Time Series Models II	15			
3	MS-SST-303	I	Introduction to Categorical Data Analysis	15	60 H	4	100 (60+40)
		II	Generalized Linear Models	15			
		III	Logistic regression & Log Linear Models	15			
		IV	Models for matched pairs & General Linear Mixed Models	15			
4	MS-SST-304	I	Introduction to Meta Analysis	15	60 H	4	100 (60+40)
		II	Basics of Structural Equation Modeling	15			
		III	Testing Theoretical Structural Models	15			
		IV	Naïve;s Classifier and Market Basket Analysis Using Association Rules	15			
5	MS-SSTP-301		Practical based on MS-SST-301	30	120 H	2	50
6	MS-SSTP-302		Practical based on MS-SST-302	30		2	50
7	MS-SSTP-303		Practical based on MS-SST-303	30		2	50
8	MS-SSTP-304		Practical based on MS-SST-304	30		2	50
			TOTAL			24	600

- **Lecture Duration – 1 hour**
- **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 -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

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: MS-SST-301
Title of Paper: Design of Experiment

Unit	Content	No. of Hours
1	**Design of Experiment** 1.1 Basics of Design of Experiments, 1.2 Randomised block design, 1.3 Latin square design, 1.4 Youden Square Design, 1.5 Balanced incomplete block design, 1.6 PBIBD, 1.7 Lattice design 1.8 Statistical analysis, Estimation of parameters, Model adequacy checking for 1.2 to 1.7.	15
2	**Factorial Experiments I** 2.1 Two factor factorial experiment: Statistical analysis of fixed effect model, Model adequacy Checking, Estimation of parameters. 2^2 , 2^3 , $\cdot 2^k$, 3^2 ,$3^3$and 3 ^{k} factorial experiment. 2.2 Factorial designs with mixed levels.	15
3	**Factorial Experiments II** 3.1 Confounding in 2^2 , 2^3 factorial designs: Complete confounding, partial confounding, fractional replication and split-plot designs. 3.2 Design useful for two way elimination of heterogeneity and their general method of analysis by using fixed effect model, Latin squares, Graeco Latin squares and Youden squares designs-	15
4	**Response Surface Methods:** 4.1 Introduction, The method of steepest ascent, Analysis of second order response surface, Experimental designs of fitting response surfaces. 4.2 The Taguchi approach to parameter design	15

Self-Learning topics (Unit wise)

Unit	Topics
1	Basics of Design of Experiments, Randomised block design, Latin square design
1	Balanced incomplete block design
2	Confounding, Partial confounding.

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

Course Code: MS-SST-302
Title of paper: Time Series Analysis

Unit	Content	No. of Hours
1	Introduction 1.1 Definition of time series .Its component. Models of time series. 1.2 Estimation of trend by: i) Freehand curve method ii) method of semi average iii)Method of Moving average iv) Method of least squares(linear trend only) 1.3 Exponential smoothing. Accuracy measurements: Mean absolute percentage error, Root mean square error. 1.4 Estimation of seasonal component by i) method of simple average ii) Ratio to moving average iii) Ratio to trend method.	15
2	Time Series Formulation : 2.1 Mathematical Formulation of time series. Time series as a discrete parameter stochastic process. Concept of strict stationary, stationary upto order 'm', Mean stationary, covariance stationary. Proof of "A strict stationary process will also be covariance stationary provided moments of order 2 exists". Counter example for disproving converse. Concept of Gaussian time series. Examples for mean stationary, covariance stationary, Gaussian time series. 2.2 Auto covariance function (ACVF) and its properties. Auto correlation function (ACF) and its properties. Partial auto correlation function (PACF). 2.3 Portmanteau tests for noise sequences, transformation to obtain Gaussian series.	15
3	Time Series Models I: 3.1 Auto regressive (AR), Moving average (MA) and Autoregressive moving average (ARMA), Stationary and inrevertibility conditions. 3.2 Non-stationary and seasonal time series models: Auto regressive integrated moving average (ARIMA) models, Seasonal ARIMA (SARIMA) models, Transfer function models (Time series regression).	15
4	Time Series Models II: 4.1 Estimation of mean, auto covariance and autocorrelation functions, Yule-Walker estimation. Forecasting in time series models. 4.2 Estimation of ARIMA model parameters, maximum likelihood method, large sample theory (without proofs). Choice of AR and MA periods, FPE, AIC, BIC. 4.3 Residual analysis and diagnostic checking, Unit-root non-stationarity, unit-root tests. 4.4 Spectral analysis of weakly stationary process. Periodogram and correlogram analysis.	15

Self-Learning topics (Unit wise)

Unit	Topics
1.1	Definition of time series .Its component.
2.2	Auto covariance function (ACVF) and its properties. Auto correlation function (ACF) and its properties. Partial auto correlation function (PACF).
3.1	Auto regressive (AR), Moving average (MA) and Autoregressive moving average (ARMA)
3.2	Auto regressive integrated moving average (ARIMA) models

Online Resources

"Applied Time Series Analysis" by Prof Arun K. Tangirala, Department of Chemical Engineering, IIT Madras **Source: https://nptel.ac.in/courses/103/106/103106123/**

Course Code: MS-SST-303

Title of paper: Categorical and Text Data Analysis

Unit	Content	No. of Hours
1	1.1 Introduction to Categorical Data Analysis: 1.2 Categorical response data, Probability distributions for categorical data. Statistical inference for discrete data. 1.3 Contingency tables: Probability structure for contingency tables, Comparing proportions with 2x2 tables, The Risk ratio and odds ratio, Tests for independence, Exact inference, Extension to three-way and larger tables. Measures of nominal and ordinal Association(Gamma and Eta Coefficients) 1.4 Text Analytics: Text Collection and Transformation, Text mining and Moedeling. 1.5 Experiential Session: Connecting to Social Media / Stock Market Site to Extract Data to cluster formation to analysis. 1.6 Introduction to Decision Tree.	15
2	Generalized linear models: 2.1 Components of a generalized linear model, 2.2 GLM for binary and count data, Statistical inference and model checking, 2.3 Fitting GLMs, **2.4** Binomial and Poisson Regression	15
3	Logistic regression: 3.1 Interpreting the logistic regression model, Inference for logistic regression. Logistic regression with categorical predictors, Multiple logistic regression, Summarizing effects, Building and applying logistic regression models, 3.2 Loglinear models for contingency tables: 3.3 Loglinear models for two-way and three-way tables, Inference for Loglinear models, The loglinear-logistic connection, Independence graphs and collapsibility. 3.4 Fitting of Logit Models and Loglinear Models.	15
4	Models for Matched Pairs: 4.1 Comparing dependent proportions, Logistic regression for matched pairs, Comparing margins of square contingency tables, Symmetry issues 4.2 Random effects: GL Mixed Models : 4.3 Random effects modeling of clustered categorical data, ,Extensions to multinomial responses or multiple random effect terms, Hierarchical models, Final notes on fitting and inference	15

Self-Learning topics (Unit wise)

Unit	Topics
1	Text Analytics: Text Collection and Transformation, Text mining and Moedeling.
3	Logistic regression: Interpreting the logistic regression model, , Building and applying logistic regression models,

Online Resources

1. Business Analytics & Text Mining Modeling Using Python, available on the Swayam portal, GOI by Prof. Gaurav Dixit, IIT Roorkee given on week 8/unit 8 **https://nptel.ac.in/courses/110/107/110107129/ for unit1**
2. Business Analytics and Data Mining Modeling using R, available on the Swayam portal, GOI by Prof. Gaurav Dixit, IIT Roorkee given on week 10 **https://nptel.ac.in/courses/110/107/110107092/ for unit 3**

Course Code: MS-SST-304

Title of paper: Applied Advance Multivariate Techniques

Unit	Content	No. of Hours
1	1.1 Meta Analysis and Its Applications: 1.2 What is Meta Analysis? Why Meta Analysis? When to go for Meta Analysis? 1.3 Theory of planned behaviour, Systematic Literature Review: planning stage, conducting stage, reporting stage, hypothesis development, bibliometric analysis, meta analysis: converting all statistics to Effect Size 1.4 Concept in Meta Analysis: Assumptions, Summary Effect, Fixed Effect / Random Effect / Mixed Effect, Heterogeneity- Identification and Quantification, Confidence Interval vs Prediction Intervals, Subgroup Analysis, Meta-Regression. Additional Concepts in Meta-Analysis: Vote Counting, Power Analysis, Reporting /Publication Bias, Cumulative Meta Analysis, Reporting Meta- Analysis	15
2	Basics of Structural Equation Modelling (SEM): 2.1 Introduction: measurement and structure models, variables and constructs, modelling strategies, conceptualization 2.2 Structural Equation Modelling: Six stages in Model Development, 1) Identification 2) Specification 3) Research design and related issues 2.3 SEM Model Estimation Measurement: Model Structure, Different Estimation Techniques, Issues of Identification 2.4 Model Validity Measurement Mode: GOFs 2.5 Specifying Structural Models: incorporating theoretical models	**15**

	2.6 Model validity: Structural models GoFs, Competitive fit, Comparing Models 2.7 Exploratory and Confirmatory Factor Analysis: Conceptualization Difference between exploratory & confirmatory factor analysis, Objective of CFA, CFA model & assessing measurements, Model validity	
3	Testing Theoretical Structural Models: 3.1 Developing Path Diagrams, Developing Overall Models and identifying Issues, Key Decision Area: Identification and Estimation, Model Validity: 4 types of validity, Bootstrapping, Model Diagnostics 3.2 Estimating SEM- CFA Model using MS Excel and Solver: demonstrating solution on MS Excel and solver for conceptual clarity 3.3 Incorporating control variables in SEM- Modelling: Interaction Effects 3.4 Mediation Analysis in SEM: incorporating mediating variables 3.5 Moderation Analysis in SEM: incorporating moderating variables Mediated Moderation Analysis: incorporating both 3.6 Advance SEM Topics Reflective v/s Formative Scales, Higher Order Factor Models, Multigroup Analysis, Latent Growth Models, Longitudinal Data Bayesian Models 3.7 Case Study	**15**
4	Naïve Baye's Classification and Market Basket Analysis Using Association Rules: 4.1 Naïve Baye's Classification: Introduction , Associated Probabilites, Case Study 4.2 Market Basket Analysis Using Association Rules 4.3 The apriori algorithm for association rule learning. Measuring rule interest – support and confidence, Building a set of rules with the apriori principle. 4.4 Case Studies: Identifying frequently purchased groceries with association rules: Data Collection / Preparation Creating a sparse matrix for transaction data Training a model on the data . Evaluating model performance . Calculating support / Confidence / Expected confidence & lift .	**15**

Self-Learning topics (Unit wise)

Unit	Topics
2.1	Introduction: measurement and structure models, variables and constructs, modelling strategies, conceptualization
2.2	Exploratory and Confirmatory Factor Analysis: conceptualization Difference between exploratory & confirmatory factor analysis, Objective of CFA, CFA model & assessing measurements, Model validity
3	Mediation Analysis in SEM: incorporating mediating variables Moderation Analysis in SEM: incorporating moderating variables
4	Naïve Baye's Classification: Introduction , Associated Probabilites, Case Study

Online Resources

2.1 Structural Equation Modelling (SEM**) by Dr. Suresh Sharma** **Day 1 - https://youtu.be/uWE1rChJtOs** **and** **Day 2 - https://youtu.be/2wniJL8M1ZQ**
2.2 'Applied Multivariate Statistical Modeling' by PROF. J. Maiti, Department of Mathematics, IIT Kharagpur, available on the NPTEL portal **https://nptel.ac.in/courses/111/105/111105091/** for unit II
3. Structural Equation Modelling (SEM**) by Dr. Suresh Sharma** **Day 3 - https://youtu.be/2VGIKmOZu9g**
4. **Business Analytics and Data Mining Modeling using R, available on the Swayam portal, GOI by Prof. Gaurav Dixit, IIT Roorkee given on week 10** **https://nptel.ac.in/courses/110/107/110107092/ for unit 4**

Part – 4- Detailed Scheme Practical

Practical of Semester III Total Credit: 08

Paper Code	Title	No. of Hours
MS-SSTP-301	Lattice Design, BIBD and PBIBD Latin and Youden Square Design 2k and 3k Factorial Experiment Mixed Level Factorial Experiment Confounding and Partial Confounding in Factorial Experiment Response Surface Methodology	02 Hours per Practical per Batch*
MS-SSTP-302	Estimation of trend and seasonal indices Autocorrelation function and partial autocorrelation function exponential smoothing Time Series Modeling of data	
MS-SSTP-303	Measure of Association Text Analytics Generalized linear models Logistic regression Loglinear models for contingency tables Models for matched pairs Random effects: GL Mixed Model	
MS-SSTP-304	Meta Analysis I Meta Analysis II Exploratory Factor Analysis Basics of SEM Confirmatory Factor Analysis Path Analysis SEM: Measurement and Structure Analysis Mediation Analysis and Moderation Analysis Naïve Bayes Classifier Market Basket Analysis	

*Batch Size of 10 students

References:

Course Code: MS-SST-301

Title of Paper: Design of Experiment

1. Montgomery, D. C. (2017). Design and Analysis of Experiments, 9th Ed, Wiley.
2. Das, M. N. and Giri, N. C. (1986). Design and Analysis of Experiments, New Age International.
3. Dean, A. and Voss, D. (2006). Design and Analysis of Experiments, 2nd, Ed, Springer.
4. Chakrabarti, M. C. (1962), Mathematics of Design and Analysis of Experiments, Asia Publishing House.
5. Raghavarao, D. (1971), Construction and Combinatorial Problems in Design of Experiments, Wiley.
6. Fisher, R. A. (1966), The Design of Experiments, Hafner Publishing Corporation.3. Cornell, J. (2002), Experiments with Mixtures Designs, Models and the Analysis of Mixture Data, 3rd Ed, Wiley.
7. Myers, R. H., Montgomery, D. C. and Cook, C. M. A. (2016). Response Surface Methodology:
8. Process and Product optimization using Designed Experiments, 4th Ed, Wiley.
9. Shah, K. R. and Sinha, B. K. (1989). Theory of Optimal Designs, Springer

Course Code: MS-SST-302

Title of Paper: Time Series Analysis

1. Brockwell, P. J. and Davis, R. A. (2003): Introduction to Time Series Analysis, Springer
2. Chatfield, C. (2001): Time Series Forecasting, Chapman &Hall.
3. Fuller, W. A. (1996): Introduction to Statistical Time Series, 2nd Ed. Wiley.
4. Hamilton, N. Y. (1994): Time Series Analysis, Princeton University press.
5. Kendall, M. and Ord, J. K. (1990): Time Series, 3rd Ed. Edward Arnold.
6. Lutkepohl, H. (2005): New Introduction to Multiple Time Series Analysis, Springer
7. Shumway, R. H. and Stoffer, D. S. (2010): Time Series Analysis & Its Applications, Springer.
8. Tsay, R. S. (2010): Analysis of Financial Time Series, Wiley.

Course Code: MS-SST-303

Title of Paper: Categorical and Text Data Analysis

1. Agresti, A. (2007),An Introduction to Categorical Data Analysis, 2nd Edition. New York: Wiley (primary text).
2. Agresti, A. (2013), Categorical Data Analysis, 3rd Edition. New York: Wiley (an advanced text).
3. Cox, D. R. and Snell, E. J. (1989), The Analysis of Binary Data. CRC Press. 2nd Edition.
4. Gokhale, D. V. and Kullback, S. (1978), The Information in Contingency Tables. Marcel Dekker.
5. Hosmer, D. W. and Lemeshow, S. (2000), Applied Logistic Regression. John Wiley, 2nd Edition
6. Lior Rokach & Oded Z. Maimon, Data Mining with Decision Trees - Theory & Applications.

Course Code: MS-SST-304

Title of Paper: **:** Applied Advance Multivariate Techniques

1. Michael Borenstein, Larry V. Hedges, Julian P. T. Higgins, Hannah R. Rothstein, Introduction to Meta Analysis, Wiley
2. John E. Hunter and Frank L. Schmidt, Methods of Meta- Analysis (Correcting Error and Bias in Research Findings), Wiley, Second Edition
3. Mike W.L.Cheung, Meta Analysis: A structural equation modeling Approach,Wiley
4. Rex B. Kline(2011), Principles and Practice of Structural Equation Modeling, Third Edition, TheGuilford Press, New York London
5. Joseph F. Hair Jr. William C. Black Barry J. Babin Rolph E. Anderson( ), Multivariate Data Analysis, Pearson New International Edition, 7th Edition
6. Lantz, B (2013), Machine Learning with R, 2nd Ed, PACKT Open Source.
7. Miller, J. D. and Forte, R. M. (2015), Mastering Predictive Analytics with R, 2nd Ed, PACKT Open Source.
8. Babcock, J. (2016), Mastering Predictive Analytics with Python, PACKT Open Source
9. https://analyticsindiamag.com/understanding-naive-bayes-classifier-from-scratch/
10. https://analyticsindiamag.com/how-to-identify-entities-in-nlp/

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**)			MS-SST-401, MS-SST-402, MS-SSTP-401,MS-SSTP-402	
2	Elective Course	Discipline Specific Elective (DSE) Course			
		2.1	Interdisciplinary Specific Elective (IDSE) Course	MS-SST-404, MS-SSTP-404	
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)			MS-SST-403, MS-SSTP-403	
	Skill Enhancement Courses (SEC)				

Detail Scheme

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Tot al Marks
			Uni ts	S. L.	L	T	P	Cre dit	S. L. E	CT	TA	SE E	
1	MS-SST-401	Non Parametric Inference	4	20% *	4	0	0	4	10	20	10	60	100
2	MS-SST-402	Advance Inference	4	20% *	4	0	0	4	10	20	10	60	100
3	MS-SST-403	Survival Analysis	4	20% *	4	0	0	4	10	20	10	60	100
4	MS-SST-404	Statistical Process Control	4	20% *	4	0	0	4	10	20	10	60	100
5	MS-SSTP-401	Practical based on MS-SST-401 Practical based on MS-SST-402					2	2			10 (J+ V)	40	50
6	MS-SSTP-402	Practical based on MS-SST-403 Practical based on MS-SST-404					2	2			10 (J+ V)	40	50
7	MS-SSTP-403	Statistical Project					4	4			10 (J+ V)	40	50
8	MS-SSTP-404										10 (J+ V)	40	50
	Total Hours / Credit							24	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	MS-SST-401	I	Introduction	15	60 H	4	100 (60+40)
		II	Tests for randomness	15			
		III	The General Two sample Problem	15			
		IV	Linear Rank Statistics	15			
2	MS-SST-402	I	Concepts of Convergence and Consistency of Estimators	15	60 H	4	100 (60+40)
		II	CAN Estimators and their Properties	15			
		III	Estimation of Parameters based on MLE	15			
		IV	MLE's for Advance Distributions and Likelihood Ration Test	15			
3	MS-SST-403	I	Concept of censoring and the various distributions	15	60 H	4	100 (60+40)
		II	Advance Inference	15			
		III	Estimation of survival function	15			
		IV	Two sample problem	15			
4	MS-SST-404	I	Capability Analysis and Cumulative sum Chart	15	60 H	4	100 (60+40)
		II	Multivariate Control Chart and Control Chart for Correlated Data	15			
		III	EWMA Control Chart	15			
		IV	Introduction to Lean and six – sigma	15			
5	MS-SSTP-401		Practical based on MS-SST-401 Practical based on MS-SST-402	30	120 H	2	50
6	MS-SSTP-402		Practical based on MS-SST-403 Practical based on MS-SST-404	30		2	50
7	MS-SSTP-403		Project	60		2	50
8	MS-SSTP-404					2	50
			TOTAL			24	600

- **Lecture Duration – 1 hour**
- **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

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: MS-SST-401

Title of Paper: **NONPARAMETRIC INFERENCE**

Unit	Content	No. of Hours
1	Introduction: 1.1 Introduction to Nonparametric Inference**,** Estimable parametric functions, kernel, symmetric kernel, one sample U-Statistic. 1.2 Two sample U-Statistic, asymptotic distribution of U-Statistics, UMVUE property of U-Statistics. 1.3 Empirical distribution function, confidence intervals based on order statistics for quantiles, tolerance regions.	15
2	**Tests for randomness:** 2.1 Tests based on the total number of runs and runs up and down. 2.2 Rank-order statistics. 2.3 One sample and paired-sample techniques: sign test and signed-rank test. 2.4 Goodness of fit problem: Chi-square and Kolmogorov-Smirnov tests.	15
3	**The General Two sample Problem:** 3.1 Two sample stochastic dominance problem, stochastic modeling of two sample location and scale problems in Nonparametric setting. 3.2 Wald Wolfwilz run test and Kolmogorov –Smirnov two sample test. 3.3 Tests for the c-sample problem: Kruskal-Wallis, Jonckheere-Terpstra tests. 3.4 Concepts of Jackknifing, method of Quenouille for reducing bias, Bootstrap methods.	15
4	**Linear Rank Statistics:** 4.1 Introduction to Linear Rank Statistics and its limiting distribution, Rank test, MP and LMP rank tests. 4.2 Tests for two-sample location problem: Wilcoxon-Mann-Whitney, Terry-Hoeffding, Van der Waerden, Median tests. 4.3 Tests for two-sample scale problem: Mood, Klotz, Capon, Ansari-Bradley, Siegel – Tukey and Sukhatme tests. 4.4 Pitman asymptoitic relative efficiency. **4.5** Independence in bivariate sample: Kendall's and Spearman's rank correlation, Equality of k independent samples.	15

Self-Learning topics (Unit wise)

Unit	Topics
1	Introduction to Nonparametric Inference
2	Goodness of fit problem: Chi-square and Kolmogorov-Smirnov tests
3	Kruskal-Wallis
4	Introduction to Linear Rank Statistics
4	Independence in bivariate sample: Kendall's and Spearman's rank correlation, Equality of k independent samples

Online Resources

Non-parametric Statistical Inference by Prof. Niladri Chatterjee https://nptel.ac.in/courses/111/102/111102143/

Course Code: MS-SST-402

Title of Paper: ADVANCE INFERENCE

Unit	Content	No. of Hours
1	**Concepts of Convergence and Consistency of Estimators** 1.1 Review of convergence in probability and convergence in distribution, Cram Slutsky's Theorems. 1.2 Consistent Estimation of real and vector valued parameters. Invariance of Consistent estimator under continuous transformation, consistency of estimators by method of moments, and method of percentiles, mean squared error criterion, asymptotic relative efficiency, error probabilities and their rates of convergence. Minimum sample size required to attain given level of accuracy.	15
2	**CAN Estimators and their Properties** 2.1 Consistent Asymptotic Normal (CAN) estimator, invariance of CAN estimator under differentiable transformation, 2.2 CAN property of estimators obtained by moments and percentiles, 2.3 CAN estimators obtained by moment, 2.4 CAN estimators for one-parameter Cramer family, 2.5 Cramer – Huzurbazar theorem.	**15**
3	**Estimation of Parameters based on MLE** 3.1 MLE method in one parameter exponential family, extension to multi-parameter exponential family, examples of consistent but not asymptotically normal estimators from Pitman family. 3.2 Method of maximum likelihood, Solution of likelihood equations, method of scoring, Newton – Raphson and other iterative procedures, Fisher Lower bound to asymptotic variance, extension to multi-parameter case (without proof). 3.3 Multinomial distribution with cell probabilities depending on a parameter.	**15**
4	**MLE's for Advance Distributions and Likelihood Ration Test** 4.1 MLE in Pitman family and double exponential distribution, MLE in censored and truncated distributions. 4.2 Likelihood Ratio Test (LRT), asymptotic distribution of LRT statistic, Wald test, Rao's score test, Pearson's chi-square test for goodness of fit, Bartlett's test for homogeneity of variances. 4.3 Large sample tests and confidence intervals based on CAN estimators, variance stabilizing transformation and large sample tests. Consistency of large sample tests, asymptotic power of large sample tests.	**15**

Self-Learning topics (Unit wise)

Unit	Not Available Topics
1	

Online Resources

Need to develop

Course Code: MS-SST-403

Title of paper: SURVIVAL ANALYSIS

Unit	Content	No. of Hours
1	**Concept of censoring and the various distributions** 1.1 Introduction to time to event data and Censoring 1.2 Concepts of Type-I (time), Type-II (order) and random censoring likelihood in these cases. 1.3 **Derivations of Survival function and Hazard function of** Life distributions: Exponential, Gamma, Weibull, Lognormal, Pareto, Linear Failure Rate.	15
2	**Advance Inference** 2.1 Inference for exponential, gamma, Weibull distributions under censoring (**Derivations of Mean and Median Survival**.) 2.2 Failure rate, mean residual life and their elementary properties. 2.3 Ageing classes and their properties, bathtub failure rate.	15
3	**Estimation of survival function**: 3.1 Actuarial estimator, Kaplan –Meier estimator, 3.2 Tests of exponentiality against non-parametric classes: Total time on Test, Deshpande Test.	15
4	**Two sample problem**: 4.1 Gehan test, 4.2 Log rank test. 4.3 Mantel-Haenszel test, 4.4 Cox's Proportional Hazards Model, 4.5 Competing Risks Model.	15

Self-Learning topics (Unit wise)

Unit	Topics
	Not Available

Online Resources

Need to Develop

Course Code: MS-SST-404

Title of paper: Statistical Process Control

Unit	Content	No. of Hours
1	Basic and Cumulative sum Charts 1.1 Review of some Basic Control Charts, Process and Measurement System. 1.2 Cumulative sum and Exponentially Weighted Moving Average Control Charts	15
2	**Multivariate Control Chart and Control Chart for Correlated Data** 2.1 Modified and Acceptance control charts. 2.2 Group control charts for multiple-stream processes. 2.3 Multivariate quality Control. 2.4 SPC with correlated data	15
3	**EWMA Control Chart and Capability Analysis** 3.1 Engineering Process Control, Process Design and Improvement with Designed Experiments, Process Optimization with Designed Experiments, Robust Deign and Signal to Noise Ratios. 3.2 Capability Analysis	15
4	**Introduction to Lean and six – sigma**: 4.1 Definition of Lean, 5 S in Lean, 7 wastes in lean, 5 principles of lean. 4.2 Definition of six – sigma and definition of Lean six – sigma. 4.3 DMAIC over view, 4.4 Define phase : VOC,VOB,VOP,CTQ,COPQ ,Project charter, DPU, DPMO, Yield, Brain Storming, SIPOC, Cause and Effect diagram 4.5 Measure phase: Process definition, Process Mapping, Value Stream Mapping, sigma calculation using sigma calculator, Gage R and R. 4.6 Improve Phase: Multi voting, Delphi Technique, Nominal group technique, Kaizen. ISO 9000	15

Self-Learning topics (Unit wise)

Unit	Topics
1	Review of some Basic Control Charts, Measurement System
3	Capability Analysis
4	VOC,VOB,VOP,CTQ,COPQ, Cause and Effect diagram

Online Resources

"Quality Control and Improvement With Minitab: by Prof. Indrajit Mukherjee, Management, IIT Bombay,
Source:**https://nptel.ac.in/courses/110/101/110101150/**

Part – 7- Detailed Scheme Practical

Practical of Semester II Total Credit: 08

Paper Code	Title	No. of Hours
MS-SSTP-401	Consistent estimator Consistent Asymptotic Normal (CAN) estimator MLE One sample Problem and Tests for Randomness Non parametric Test for Two sample Problem Non parametric Test for C sample Problem Linear Rank Test	02 Hours per Practical per Batch*
MS-SSTP-402	Survival Analysis Estimation of survival function Two Sample Problem Cumsum Chart Process Capability Analysis Control Chart for Correlated Data Multivariate Control Chart Gage R and R EWMA Control Chart	
MS-SSTP-403	Statistical Project for Group of students (team of 4-5 students).	
MS-SSTP-404		

*Batch Size of 10 students.

* MS-SSTP-403 and MS-SSTP-404 together of 100 marks is evaluated based on the project report submitted by the students and presentation based on the analysis of project as,
Guide's assessment- 40 marks
External judge's Assessment- Total 60 marks =Presentation (40 marks) + Viva (20 marks)

REFERENCES:

Course Code: MS-SST-401
Title of Paper: NONPARAMETRIC INFERENCE

1. Gibbons, J.D. (1985), Nonparametric Statistical Inference, 2nd ed., Marcel Dekker, Inc.
2. Randles, R.H. and Wolfe, D.A. (1979), Introduction to the theory of nonparametric statistics, John Wiley and Sons Inc.
3. Davison, A.C. and Hinkley, D.V. (1997), Bootstrap Methods and their application, Cambridge University Press.
4. Daniel, W.W. (2000), Applied Nonparametric Statistics (2nd Ed.), Wiley
5. Hajek, J. and Sidak, Z. (1967), Theory of rank tests, Academic Press.
6. Puri, M.L. and Sen, P.K. (1971), Nonparametric methods in multivariate analysis, John

Wiley & Sons, Inc.

Course Code: MS-SST-402

Title of Paper: ADVANCE INFERENCE

1. Kale, B.K. (1999), A first Course on Parametric Inference, Narosa Publishing House.
2. Rohatgi, V. and Saleh, A.K.M.E. (2010), Introduction to Probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi (Student Edition
3. Lehmann, E.L. (1986), Testing Statistical hypotheses (Student Edition). Wiley.
4. Rao, C.R. (1973) , linear Statistical Inference. Wiley Eastern.
5. Dudewicz, E.J. and Mishra, S.N. (1988), Modern Mathematical Statistics. Wiley Series in Prob. Math. Stat., John Wiley and Sons New York (International Student Edition).
6. Ferguson, T.S. (1996), A course on Large Sample Theory. Chapman and Hall, London.

Course Code: MS-SST-403

Title of paper: SURVIVAL ANALYSIS

1. Miller, R.G. (1998), Survival Analysis, Second Edition, Wiley Interscience.
2. Cox, D.R. and Oakes, D.(1984), Analysis of Survival Data, Chapters 1, 2, 3,4. Taylor and Francis
3. Applied Survival Analysis- A Practical Approach by David Machin, Yin Bun Cheung and Mahesh K. Parmer, Wiley Publication, 2nd Edition
4. Jayant V. Despande and Sudha Purohit(2005), LifeTime Data: Statistical Models and Methods, World Scientific Publishing Co. Pvt. Ltd
5. Survival Analysis: A Self Learning Text by David G. Kleinbaum and M. Klein, Third Edition
6. Wayne W. Daniel (1995). Biostatistics , ch-Applied Survival Analysis, Wiley
7. Crowder M. J.(2001), Classical Competing Risks, Chapman & Hall, CRC, London.
8. Gross, A.J. & Clark, V.A. (1976), Survival Distributions-Reliability Applications in Bio-medical Sciences, Chapters 3,4, John Wiley and Sons.
9. Kalbfleisch J.D. and Prentice R.L. (1980) ,The Statistical Analysis of Failure Time Data, John Wiley and Sons.

Course Code: MS-SST-404

1. Duncan, A. J. (1986), Quality Control and Industrial Statistics. Irwin. 5th Edition.
2. Grant, E. L. and Leavenworth, R. (2017), Statistical Quality Control. McGraw Hill. 7th Edition.
3. Johnson, N. L. (1977), Statistics and Experimental Design in Engineering and Physical Science. John Wiley.
4. Montgomery, D. C. (2004), Introduction to Statistical Quality Control. John Wiley. 4th Edition.
5. Muralidharan, K. (2015), Six sigma for organizational Excellence: A statistical approach. Springer.
6. Phadke, M. S. (1989), Quality Engineering Using Robust Design. Pearson.
7. Taguchi, G. (1986), Introduction to Quality Engineering: Designing quality into products and processes. Quality resources.