

॥ सा विद्या या विमुक्तये ॥



# स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

“ज्ञानतीर्थ” परिसर, विष्णुपुरी, नांदेड - ४३१६०६ (महाराष्ट्र)

**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED**

“Dnyanteerth”, Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)

Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade



## ACADEMIC (1-BOARD OF STUDIES) SECTION

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प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचा CBCS Pattern नुसारचा अभ्यासक्रम शैक्षणिक वर्ष २०१९-२० पासून लागू करण्याबाबत.

## परिपत्रक

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक ०८ जून २०१९ रोजी संपन्न झालेल्या ४४व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/४४-२०१९ च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचा खालील विषयाचा **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचा अभ्यासक्रम शैक्षणिक वर्ष २०१९-२० पासून लागू करण्यात येत आहेत.

### 1. M.A. / M.Sc. – I Year - Statistics

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या [www.srtmun.ac.in](http://www.srtmun.ac.in) या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

‘ज्ञानतीर्थ’ परिसर,

विष्णुपुरी, नांदेड – ४३१ ६०६.

जा.क्र.: शैक्षणिक-१ / परिपत्रक / संकुले / पदव्युत्तर-

सीबीसीएस अभ्यासक्रम / २०१९-२० / १७४०

दिनांक : १६.१०.२०१९.



स्वाक्षरित / -

**उपकुलसचिव**

शैक्षणिक (१-अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :

- १) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
- २) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
- ३) मा. संचालक, गणितीय शास्त्रे संकुल, विद्यापीठ परिसर, प्रस्तुत विद्यापीठ.
- ४) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
- ५) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
- ६) सीनिअर प्रोग्रामर, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

**Swami Ramanand Teerth Marathwada University,  
Nanded  
School of Mathematical Sciences**

**Two Year M. A. / M. Sc. Degree Program in Statistics**

**Revised Syllabi of M. A. / M. Sc. in Statistics  
(Choice Based Credit System)**

**(To be implemented in the Department of Statistics, Swami  
Ramanand Teerth Marathwada University, Nanded)**

**M. A. / M. Sc. in Statistics**

**(With effect from Academic Year 2019-2020)**

**Program Code: SMS-S-STA-PG**

**Numeric Code: 20-2-2-01**

## **Title of the Program: M. A. / M. Sc. in Statistics**

### **❖ Vision:**

To organize, connect, build and communicate statistical concepts effectively through devotion, determination, obedience and path. Contribute subject knowledge to promote the students for development among ethical value-based learning to nurture creativity, research and development.

### **❖ Mission:**

- To enhance the logical and analytical skills in solving problems.
- To inculcate research culture the students.
- To serve as an enabler in Statistics Programme higher education and research that match global benchmarks.
- Adapting to ever-changing needs of the Academics, Banking and industries etc. sector.
- Promoting international understanding through quality education.

**1. Preamble/Prerequisites:** M. A. / M. Sc. Statistics programme is of minimum 100 credits spread over four semesters. The programme emphasizes both theory and applications of statistics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, number of elective courses, extensive computer training of statistical computations including standard software packages such as MATLAB, MINITAB, R, TORA and SPSS. The department has the academic autonomy and it has been utilized to add the new and need based elective courses. The independent project work is one of the important components of this program. In this syllabus core courses, electives and open electives are offered. The syllabus has been framed to have a good balance of theory, methods and applications of statistics. It is possible for the students to study basic courses from other disciplines such as economics, life sciences, computer science and mathematics in place of electives. This programme requires basic of data types, organization of data and tabulation of data, Graphical representation, data transformation, distribution theory, and sampling methodology.

A course with STATC, STATE, STATPC and STATOE indicates program title, a core theory course indicated by 'C'; elective theory course indicated by 'É'; 'P' is for practical from semester one to three and fourth semester for Project and OE indicated for Open electives respectively. A student can enroll for a practical course if the student has enrolled for the corresponding theory course (as indicated) in the same term.

## **2. Program Educational Objectives (PEO):**

M. A. / M. Sc. Statistics program has semester pattern and credit system with variable credits. The program consists of 100 credits. Credits of a course are specified against the title of the course. The learning objectives of this program are:

**PEO1:** Students should be able to understand, implement and overcome problems through statistical techniques.

**PEO2:** To develop scientific view among students for better understanding and analytic ability the collected data for specific perspectives.

**PEO3:** Demonstrate graduate-level skills in communicating mathematics and statistics, orally and in writing.

**PEO4:** Students should be able to understand appropriate, relevant, fundamental and applied mathematical; and statistical methodologies and modern computational tools.

**PEO5:** The ability to bring together and flexibly apply knowledge to characterize, analyze and solve a wide range of problems an understanding of the balance between the complexity / accuracy of the mathematical / statistical models used and the timeliness of the delivery of the solution.

**PEO6:** Ability to contribute to professional work settings through effective participation in teams and organization of project tasks the ability to constructively engage with other team members and resolve conflict.

**PEO7:** The ability to communicate effectively in terms of technical and non-technical material in a range of forms to different audiences.

## **4. Program Outcomes (PO):**

On successful completion of the program students will be able to:

**PO1:** Have specialised knowledge and understanding of statistical theory at an advanced level which take into account recent advances in the subject.

**PO2:** Acquire the strong foundation of statistical concepts which will benefit them to become good academicians.

**PO3:** Use acquired statistical methodologies and modelling techniques to address real-life problems.

**PO4:** Gain the knowledge of software which has the wide range of opportunities in the Quality control, Planning and development, IT sector, R&D in industries, Business, Government and private sector etc.

**PO5:** Qualify various National / State level competitive exams like ISS, DSO, CSIR-UGC NET, SLET, GATE, MPSC, UPSC, Banking etc.

## **5. Program Specific Outcomes (PSO):**

On successful completion of the program students will be able to:

**PSO1:** Understand, implement and develop statistical models.

**PSO2:** Handle and analyze small as well as large databases with computer skills.

**PSO3:** Describe complex statistical ideas to non-statisticians and to present the results of their analyses in written, oral forms and can make practical suggestions for improvement.

**PSO4:** Get wide range of statistical skills in problem-solving.

**PSO5:** The project work and presentation may enable to take prominent roles in a wide spectrum of employment and research.

## **6. Course Outcomes (for all courses):**

The course outcomes are the statement that describes the knowledge & abilities developed in the student by the end of course (subject) teaching. The focus is on development of abilities rather than mere content. There are 4 course outcomes of all courses defined here. These are to be written in the specific terms and not in general.

### **6.1. Set Target levels for Attainment of Course Outcomes:**

The course outcome attainment is assessed in order to track the graduates' performance with respect to target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment are measured/calculated. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

### **6.2. Set Target level for Attainment of Program Outcomes:**

The program outcome attainment is assessed in order to track the graduates' performance with respect to target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning and teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment and program outcome attainment is measured/calculated. The program outcome attainment is governed by curricular, co-curricular and extra-curricular activities including the stakeholders' participation. The direct method and indirect method is adopted to calculate the PO attainment. The direct method implies the attainment by course outcomes contributing to respective program outcomes. And indirect method is the satisfaction/ feed-back survey of stakeholders. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done. The set target level is the set benchmark to ensure the continuous improvements in the learners/ graduates' performance.

### **6.3. Course Attainment Levels:**

- a) CO attainment is defined / set at three levels;
- b) The CO attainment is based on end term examination assessment and internal assessment;
- c) The Co attainment is defined at three levels in ascending order

#### **d) Course Levels:**

- i) Level-1: 40% students score greater than or equal to class average
- ii) Level-2: 50% students score greater than or equal to class average
- iii) Level-3: 60% students score greater than or equal to class average

#### **Target Level: Level – 2**

e) The target level is set (e.g. Level-2). It indicates that, the current target is level-2; 50% students score more than class average. The CO attainment is measured and the results are obtained. Based on the results of attainment, the corrective measures/remedial action are taken.

f) CO Attainment= 80% (Attainment level in end term examination) + 20% (Attainment level in internal examination).

**g) The example of calculating CO attainment is provided for one of the course.**

#### **Program attainment Level:**

a) PO attainment is defined at five levels in ascending order;

b) The PO attainment is based on the average attainment level of corresponding courses (Direct Method) and feed-back survey (Indirect method);

c) The PO attainment levels are defined / set as stated below;

- i) Level-1: Greater than 0.5 and less than 1.0 (0.5>1) - Poor
- ii) Level-2: 1.0>1.5-Average
- iii) Level-3: 1.5>2.0-Good
- iv) Level-4: 2.0>2.5-Very Good
- v) Level-5: 2.5>3.0 –Excellent

d) The PO attainment target level is set/defined (say, Level-4). It implies that, the department is aiming at minimum level-4 (very good) in the performance of abilities by the graduates. Based upon the results of attainment, the remedial measures are taken;

e) PO Attainment= 80% (Average attainment level by direct method) + 20% (Average attainment level by indirect method).

#### **For Example:**

##### **Course Code/Title: STA-101 REAL ANALYSIS**

e.g. For end term and internal examination;

- i. Level-1: 40% students scored more than class average
- ii. Level-2: 50% students score more than class average;
- iii. Level-3: 60% students score more than class average

Average Marks in External examination: 26

% Students score more than 26 is 58/100 i.e. 58.00% i.e. Level-2

Average Marks in Internal examination= 7

% Students score more than 7 is 71/100 i.e.71.00%, i.e. Level-3

A (CO) STA-101 = 80% (2) +20(3)

=1.6+0.6

= 2.2

Hence, the attainment level is Level-2 and the set target level is Level-2 and therefore the CO is fully attained.

**7. Eligibility:** For M. A. / M.Sc. in Statistics following candidates are eligible.

- B. A. / B. Sc. with Statistics/ Mathematics as a principal subject.

## **8. Definitions:**

### **Credits:**

Credit is a kind of weightage given to the contact hours to teach the prescribed syllabus, which is in a modular form. Normally one credit is allocated to 15 contact hours.

- In each of the courses, credits will be assigned on the basis of the number of lectures / tutorials / laboratory work and other forms of learning required for completing the course contents in maximum 18 week schedule.
- The instructional days as worked out by the UGC for one academic year are 180 working days i.e. 90 days per semester.
- **Mechanics of Credit Calculation:** As per SRTMUN standard, 1Credit= 15 contact hours. 60 Contact hours will include all the modes of teaching like lectures / tutorials / laboratory work / fieldwork or other forms which suits to that particular course. In determining the number of hours of instruction required for a course involving laboratory / field-work, 2 hours of laboratory / field work is generally considered equivalent to 1 hour of lecture.

### **I. Credit Point (P):**

Credit point is the value obtained by multiplying the grade point (G) by the credit (C):  $P = G \times C$ .

### **II. Grade Point:**

Grade point is an integer indicating the numerical *SEMESTER GRADE POINT AVERAGE (SGPA)*:

**III. Semester Grade Point Average (SGPA)** is the value obtained by dividing the sum of credit points (P) earned by a student in various courses taken in a semester by the total number of credits earned by the student in that semester. SGPA shall be rounded off to two decimal places.

### **IV. Cumulative Grade Point Average (CGPA):**

'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses earned by a student for the entire programme, by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicate an overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his/her CGPA. The comprehensive academic performance of a student in a programme is equivalent of the letter grade.

➤ **Evaluation System -**

In this section the broad guidelines to be followed in evaluation system and the minimum number of credits to be completed to get a degree are defined.

- a. The evaluation will be on Mid Semester Assessment (MSA), End Semester Assessment (ESA). The final results shall be declared after integration of MSA and ESA.
- b. Weightage: 50% for End Semester Assessment (ESA) & 50% for Mid Semester Assessment (MSA).

The declaration of result is based on the grade point average (GPA) earned towards the end of each semester or the Cumulative Grade Point Average (CGPA) earned towards the end of the program.

The Post-graduate degree will be awarded to those students who earn the minimum number of Credits. For the award of degree the student has to acquire minimum number of credits as per the table given below.

Name of the Faculty/course	Total credits	Average credits per semester
M.A./ M.Sc.	100	25

- a. One credit will be equivalent to 15 clock hours of teacher-student contact in a semester.
- b. Four –credit course of theory will be of four clock hours per week.
- c. Three- credit course of practical will be of 6 hours of lab exercise/field.
- d. The project will be commencing from Semester III and the final work & report will be completed during Semester IV. The marks & the credits will be allotted in semester IV.
- e. There will be no mid-way change allowed from Credit System to Non-credit (external) System or vice versa.
- f. Except the credits for practical courses, wherever applicable, a student can register for less number of courses in a semester subject to the condition that such a student will have to complete the degree in a maximum of five, four and two years respectively for three, two and one year programs. This facility will be available subject to the availability of concerned courses in a given semester and with a maximum variation of 25 % credits (in case of fresh credits) per semester.

g. **CBCS:**

Among the minimum number of credits to be earned by a student to complete a Post Graduate degree program (100 credits), the student will have to earn minimum 75% credits from the core subjects and the remaining 25 % credits could be earned from the elective/open elective (inter/intra disciplinary) subjects offered within and across the schools. The maximum number of credits offered across the disciplinary should not exceed 10% of total credits for the program.

**The distribution of the courses in a Program:** The total number of minimum credits to complete the program is different for different programs. Out of these:

**Core: 75%** of total credits of the Program of that particular discipline.



**Elective: 25%** (including discipline specific subject electives and Open (Generic) Electives). In this the **open electives should be of 8 credits** in a two year program (average of 4 credits each year). It is recommended that the **open electives shall be of outside the parent school** i.e. Inter school. This includes Credit Transfer from recognized online courses like SWAYAM/ MOOCS/ NPTEL/Skill oriented courses.

- h. **Credit transfer from other Institutes:** Depending on the feasibility and availability a maximum of four credits can be completed by the student in any of the national or reputed institutes/organizations/companies/ industries (HOST). For this a student has to complete a minimum number of 15 interactive hours (not necessarily only teaching) with assigned faculty from host. It may be 3-4 interactive hours in a day and the necessary certificate in this regard shall be issued by host faculty. The Director of the school can fix this credit transfer mechanism with mutual consent/understanding form any host institute. After completion of minimum required interactive/teaching hours at the chosen institute the Host has to provide course completion certificate with a grade. The assessment will be made by the concerned faculty of the host and one Faculty/ Director of the concerned school (Parent) and performance grade and marks will be allotted. The same marks shall be sent to university examination section along with other marks for declaration of the results by the concerned school.
- i. **Audit Courses and Additional courses:** If the student wishes to go for more number of credits, he can opt additional courses up to maximum of 10% of the total credits of the program depending on the interest of the student and other feasibilities. In general audit courses are of qualitative assessment without grades and additional credits are with grades. These additional credits shall be reflected on the Marks transcript of the student.

#### 9. Guidelines to Choose Open Elective Course:

1. After taking admission in to a particular Program in the University the student has to select courses of open electives of his choice based on eligibility from other school to completely fulfil the minimum number of credits for award of degree.
2. The open electives can be selected by the student from the list available with school/prospectus.
3. He has to apply in the format to the Director of concerned schools where the particular chosen electives is being offered. The Open Elective Pro-forma should be made available to all students in the Schools.
4. After submission the applications scrutinized by the respective schools and the selected list of candidates will be displayed on the notice board with copy to the school director in which the candidate has taken admission for his basic degree.
5. It is the responsibility of the student to check the admission in to particular open elective course.
6. There will be a common time table for open electives in all the schools.
7. The assessment of open electives will be as per the norms of CBCS University guidelines and the host school offering the particular course.
8. The school should communicate the assessment results of the open electives to the Parent School.
9. Any difficulty in operating the open elective course shall be resolved by the Directors of the respective schools in consultation with concerned authority if necessary.
10. The list of open elective shall be updated by the schools from time to time based on the reviews/demand/expertise/needs of the society.

## 10. Examination/Evaluation Rules

The evaluation of the student will be mainly on

1. **Mid semester Assessment (MSA) and**
2. **End Semester Assessment (ESA).**
3. **The ratio of MSA and ESA is 50:50**

### **Passing Rules:**

The MSA and ESA shall have different passing heads and Minimum passing:- 40% of passing for each subject in each head. To pass the degree program, a student will have to obtain a minimum aggregate of 40% marks (C+ and above in grade point scale) in each course.

### **Assessment:**

#### **Mid Semester Assessment (MSA):**

MSA aims to assess values, skills and knowledge imbibed by students, internal assessment is to be done by the concerned faculty member, department, school or the centre. **MSA** will be done on a continuous basis during the semester with selected assessment components.

#### **The components selected for MSA may be:**

Tests, Quiz, Seminars, Assignments, essay, tutorials, term paper, seminar, laboratory work, field work, workshop practice, Comprehensive Viva, Attendance and any other best and innovative assessment practice approved by the School committee. Components of internal evaluation are to have a time frame for completion (by students), and concurrent and continuous evaluation (by faculty members).

The evaluation outcome shall be expressed initially by predetermined marks and latter converted by grades. Minimum Mark for passing in each Paper is 40% for Mid Semester Assessment (**MSA**)

**End Semester Assessment (ESA):** This is to be carried out at the end of each semester, and will aim to assess skills and knowledge acquired by the students through classroom instruction, fieldwork, laboratory work and/or workshop practice. The End Semester Assessment (ESA) is based on written examination. These examinations shall be at the end of each semester.

**Integration of MSA and ESA:** A student failed in MSA shall have to appear for ESA again in that particular paper. In a particular paper if a student failed in Mid Semester (MSA), he deemed to be failed in that course and he has to reappear for MSA and ESA irrespective of the marks he got in ESA. If a student passed in MSA and failed in ESA, the student needs to appear for ESA only in his next attempt and the MSA marks shall be carried.

A candidate who does not pass the examination in any course(s) shall be permitted to appear in such failed course(s) in the subsequent examinations to be held in winter/summer season. However the student has to clear the course in the prescribed maximum period for that course.

MSA marks will not change. A student cannot repeat MSA. In case s/he wants to repeat MSA, then s/he can do so only by registering the said course during the semester in which the course is conducted and up to 4 years (2 years program) as the case may be, provided the student was failed in that course. Students who have failed in a course may reappear for the ESA only twice in the subsequent period. If student fail to acquire required

Credits within four years from admission period, such student has to acquire Credits with prevailing / revised syllabus at that time. After that, such students will have to seek fresh admission as per the admission rules prevailing at that time.

A student cannot register for the third/fourth semester, if she/he fails to complete 75% credits of the total credits expected to be ordinarily completed within two semesters.

While marks will be given for all examinations, they will be converted into grades. The semester end grade sheets will have only grades and final grade sheets and transcripts shall have grade points average and total percentage of marks (up to two decimal points).

### **11. Assessment and Grade point average:**

**11.1** The system of evaluation will be as follows: Each MSA and ESA will be evaluated in terms of marks. The marks for MSA and ESA will be added together and then converted into a grade and later a grade point average.

**11.2** Results will be declared for each semester.

**11.3** After the completion of minimum number of credits of a program, a student will get a grade sheet with total grades earned and a grade point average.

### **11.4 Marks/Grade/Grade Point:**

**i) Table 1: Conversion of marks to grades in credit system**

<b>Marks Obtained</b>	<b>Grade</b>	<b>Grade Points</b>
100-90	S	10
89-80	O	09
79-70	A+	08
69-60	A	07
59-55	B+	06
54-45	B	05
44-40	C+	04
39 and Less FC	FC	0 (Fail but Continue)
39 and Less (Internal)	FR	0 (Fail and Repeat the course)

**ii)** A student who passes the internal tests but fails in Term End Examination of a course shall be given FC grade. Student with FC grade in a course would be granted credit for that course but not the grade for that course and shall have to clear the concerned course within 1.5 year from appearing for first time in the concerned paper, provided the number of courses with FC and FR grades together is 25% or less of the courses of that semester, failing which he/she shall be disqualified for a credit and will have to opt for another credit.

**iii)** Student who has failed in the internal tests of a course shall be given FR grade and shall have to repeat the concerned course to qualify to appear for term end examination of that course. The grade FC and FR will be taken into consideration while calculating Semester Performance Index (SPI). It shall be replaced only when student clears the course with passing grade within 1.5 year from appearing for first time in the concerned semester.

iv) Grade points earned in each paper shall be calculated as- Grade points obtained (vide Table 1 above) X Credits for the paper.

**Maximum grade points that can be earned in a semester are 200.**

v) The Semester Performance Index (SPI) gives weighted performance index of a semester with reference to the credits of a course. The SPI shall be calculated as-  
 SPI = Total Earned Grade Pointes (as given above) for the Semester  
 Total Credits for the semester

**11.5** The total grade point earned in each course shall be calculated as:

Grade point obtained as shown in table -1 X Credits for the Course

**11.6 Semester Grade Point Average (SGPA):** The performance of the student in a semester is indicated by number called SGPA. It shall be calculated as follows:

$$SGPA = \frac{\sum_{i=1}^n c_i p_i}{\sum_{i=1}^n c_i}$$

Where  $C_i$  = The number of Credits earned in the  $i^{th}$  course of a semester for which SGPA is to be calculated.

$p_i$  = Grade point earned in the  $i^{th}$  course.

$i = 1,2,3,4,\dots,n$  represent the number of courses in which a student is registered in the concerned semester.

That is

$$SGPA = \frac{\text{Total earned grade point for the semester}}{\text{Total credits for the semester}}$$

**11.7 Final result:**

The final marks after assessment will be submitted by the respective schools to the controller of Examination for finalization of the results. Up to date assessment of the overall performance of a student from the time of his / her first registration is obtained by calculating a number is called as Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all courses registered by the student since he / she entered the department.

$$CGPA = \frac{\sum_{j=1}^m c_j p_j}{\sum_{j=1}^m c_j}$$

Where  $C_j$  = The number of Credits earned in the  $j^{th}$  course up to the semester for which CGPA is to be calculated.

$p_j$  = Grade point earned in the  $j^{th}$  course.

$j = 1, 2, 3, 4\dots m$  represent the number of courses in which a student is registered up to the semester for which the CGPA is to be calculated.

➤ **Final Grade: Table -2**

CGPA	Grade
09.00-10.00	S: Super
08.00-08.99	O : Outstanding
07.50-07.99	A+: Excellent
07.00-07.49	A: Very Good
06.00-06.99	B+: Good
05.00-05.99	B: Satisfactory
04.00 -04.49	C+: Pass

**11.8** 'B+' Grade is equivalent to at least 55% of the marks as per circular No. UGC- 1298/ [4619] UNI- 4 dated December 11, 1999.

**11.9** "A" Grade is equivalent to first class.

**11.10** If the (C) GPA is higher than the indicated upper limit in the three decimal digit, then higher final grade will be awarded (e.g. a student getting (C)GPA of 3.992 may be awarded 'C+' grade).

**11.11** For grade improvement a student has to reappear for End Semester Examination (ESE) after the successful completion of the course for a minimum 20 credits in case of Science, Technology, Management and Pharmacy, 20 credits for other faculties and 12 credits in case of one year degree program. These courses will be from the parent Department (core subject). A student can appear only once for the Grade Improvement Program only after the successful completion of UG / PG Degree program and at the end of the next academic year after completion of the Degree and within two years of completion of the Degree.

**11.12** The formula for CGPA will be based on Weighted Average. The final CGPA will not be printed unless a student earns minimum 100 credits, 80 credits or 64 credits, as the case may be, from the courses at UG / PG programs.

**11.13** If a student failed to obtain a grade other than F in a course then such a course will not be taken into account for calculating CGPA and overall grade. In fact, all the courses in which a student has passed will be taken into account for calculating the CGPA and overall grade.

**12. Norms & Procedure for Extra Credit Benefit for NSS or Participation:**

The following table shows the grades along with grade point to be given to the students participating in the NSS / Sports activities:

The student should avail the only one benefit neither from NSS or Sport activities.

**Maximum addition of Grade point = 0.200**

Sr. No.	Event	Specification	Grade point
1	NSS Performance	2 Year regular Programme [ 240 hrs work + Blood donation + Camp (State / National Level)]	0.200
2	Sports Performance	Intercollegiate : I /II /III	0.150
		Inter- University : I /II /III or Participation	0.200

## Structure of the course (w.e.f. 2019-20)

### M.Sc. (Statistics)-I year (CBCS Pattern)

#### SEMESTER-I

Sr. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks @ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
STATC 101	Core I	Real Analysis	L/T	4	100	50	50	100
STATC 102	Core II	Linear Algebra	L/T	4	100	50	50	100
STATC 103	Core III	Distribution Theory	L/T	4	100	50	50	100
STATC 104	Core IV	Sampling Methods	L/T	4	100	50	50	100
STATE 105	Elective Group I (04 Credit)	Statistical Computing (R Programming)	L/T	4	100	50	50	100
STATE 106		Computer Graphics	L/T	4	100	50	50	100
STATE 107		Statistics Education and Research Methodology	L/T	4	100	50	50	100
STATE 108		04 Credit Course from intra School	L/T	4	100	50	50	100
STATE109		04 Credit Course from inter School/ NPTEL/SWAYAM/ MOOC Online certified course etc.	L/T	4	100	50	50	100
Elective (02 credit)	ELE-1 Select any one (Inter) Soft Skill I		L/T	2	50	25	25	50
STATPC 01	Core Practical I	Practical-I (based on STATC 101 to 104)	P	3	75	--	75	75
		<b>Total</b>						<b>625</b>

#### Note:

- STATE 105 Statistical Computing (R Programming) course (04 credits) is offered for other programme students for Intra School students.

## SEMESTER-II

Sr. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks @ 25/ Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
STATC 201	Core V	Probability Theory	L/T	4	100	50	50	100
STATC 202	Core VI	Regression Analysis	L/T	4	100	50	50	100
STATC 203	Core VII	Parametric Inference	L/T	4	100	50	50	100
STATC 204	Core VIII	Stochastic Processes	L/T	4	100	50	50	100
STATE 205	Elective Group II (04 Credit)	Calculus	L/T	4	100	50	50	100
STATE 206		Demography	L/T	4	100	50	50	100
STATE 207		Statistical Methods in Epidemiology and Ecology	L/T	4	100	50	50	100
STATE 208		Categorical Data Analysis	L/T	4	100	50	50	100
STATE 209		04 Credit Course from intra School	L/T	4	100	50	50	100
STATE 210		04 Credit Course from inter School/ NPTEL/SWAYAM/ MOOC Online certified course etc.	L/T	4	100	50	50	100
Elective (02 credit)	ELE-2 Select any one (Inter) Soft Skill II		L/T	2	50	25	25	50
STATPC 02	Core Practical II	Practical-I I (based on STATC 201 to 204)	P	3	75	--	75	75
		<b>Total</b>						<b>625</b>

**Note:**

- STATE 207 Statistical Methods in Epidemiology and Ecology course (04 credits) is offered for other programme students for Intra School students.

## M.Sc. (Statistics)-II year (CBCS Pattern)

### SEMESTER-III

Sr. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks@ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
STATC 301	Core IX	Industrial Statistics	L/T	4	100	50	50	100
STATC 302	Core X	Operations Research-I	L/T	4	100	50	50	100
STATC 303	Core XI	Design of Experiments	L/T	4	100	50	50	100
STATC 304	Core XII	Testing of hypotheses	L/T	4	100	50	50	100
STATE 305	Elective III (04 Credit)	Time Series Analysis	L/T	4	100	50	50	100
STATE 306		Decision Theory	L/T	4	100	50	50	100
STATE 307		Statistical Methods in Finance	L/T	4	100	50	50	100
STATE 308		Mathematical Biology	L/T	4	100	50	50	100
STATE 309		04 Credit Course from intra School	L/T	4	100	50	50	100
STATE 310		04 Credit Course from inter School/ NPTEL/SWAYAM/ MOOC Online certified course etc.	L/T	4	100	50	50	100
Elective (02 credit)	ELE-3 Select any one (Inter) Soft Skill III		L/T	2	50	25	25	50
STATPC 03	Core Practical III	Practical-III (based on STATC 301 to 304)	P	3	75	--	75	75
		<b>Total</b>						<b>625</b>

**Note:**

- STATC 302 Operations Research-I and STATE 307 Statistical Methods in Finance course (04 credits) is offered for Intra School students.



**SEMESTER-IV**

Sr. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks@ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
STATC 401	Core XIII	Asymptotic Inference	L/T	4	100	50	50	100
STATC402	Core XIV	Operations Research-II	L/T	4	100	50	50	100
STATC 403	Core XV	Multivariate Analysis	L/T	4	100	50	50	100
STATC 404	Core XVI	Reliability and Survival Analysis	L/T	4	100	50	50	100
STATE 405	Elective Group IV (04 Credit)	Data Mining Techniques	L/T	4	100	50	50	100
STATE 406		Directional Data Analysis	L/T	4	100	50	50	100
STATE 407		Actuarial Statistics	L/T	4	100	50	50	100
STATE 408		Statistical techniques in Microarray Data Analysis	L/T	4	100	50	50	100
STATE 409		Clinical Trials	L/T	4	100	50	50	100
STATE 410		04 Credit Course from intra School	L/T	4	100	50	50	100
STATE 411		04 Credit Course from inter School/ NPTEL/SWAYAM/ MOOC Online certified course etc.	L/T	4	100	50	50	100
Elective (02 credit)	ELE-4 Select any one (Inter) Soft Skill IV		L/T	2	50	25	25	50
STATP C04	Core Project	Project	P	3	75	--	75	75
		<b>Total</b>						<b>625</b>

**Note:**

- STATC 402 Operations Research-II (For STATC 402 essential prerequisite is STATC 302) and STATE 409 Clinical Trials course (04 credits) is offered for Intra School students.

**List Open electives to be offered** (8 credits in a four semester program):

<b>M.A./ M.Sc. Statistics Programme</b>						
<b>S.N.</b>	<b>Course code</b>	<b>Title of Open elective course</b>	<b>No of Credits (minimum of 2 credits)</b>	<b>Semester in which it is offered</b>	<b>Prerequisite of the student (eligibility)</b>	<b>Course instructor</b>
1	STATOE01	Data Analysis with Advanced Excel	02	Semester I /III (ODD)	Basics of descriptive statistics	Dr. G. S. Phad
2	STATOE02	Statistical Analysis Using R	02		Basics of statistics	Dr. A. A. Muley
3	STATOE03	Introduction to Data Mining	02	Semester II/IV (Even)	Basics of statistical techniques	Dr. A. A. Muley
4	STATOE04	Data analysis using SPSS	02		Basics of statistics	Dr. G. S. Phad

**List of Core/ Elective Subjects to be offered**

**Core Subjects**

1. Real Analysis
2. Linear Algebra
3. Distribution Theory
4. Sampling Methods
5. Practical-I (based on STATC 101 and STATC 104)
6. Probability Theory
7. Regression Analysis
8. Parametric Inference
9. Stochastic Processes
10. Practical-II (based on STATC 201 to STATC 204 )
11. Industrial Statistics
12. Operations Research-I
13. Design of Experiments
14. Testing of hypotheses
15. Practical-III (based on STATC 301 to STATC 304)
16. Asymptotic Inference
17. Operations Research-II
18. Multivariate Analysis
19. Reliability and Survival Analysis
20. Project (03 credits)

**Elective Subjects**

**Elective Group I (Any one for First Semester) (04 Credit)**

1. Statistical Computing (R Programming)
2. Computer Graphics
3. Statistics Education and research Methodology

4. 04 Credit Course from Intra School

**Elective Group II (Any one for Second Semester) (04 Credit)**

1. Calculus
2. Demography
3. Statistical Methods in Epidemiology and Ecology
4. Categorical Data analysis
5. 04 Credit Course from other Programme within or other School

**Elective Group III (Any one for Third Semester)**

1. Time Series Analysis
2. Decision Theory
3. Statistical Methods in Finance
4. Mathematical Biology
5. 04 Credit Course from Intra School

**Elective Group IV (Any one for Fourth Semester)**

1. Data Mining Techniques
2. Directional Data Analysis
3. Actuarial Statistics
4. Statistical techniques in Microarray data analysis
5. Clinical Trials
6. 04 Credit Course from Intra School

**Elective: STATE 109, 210, 310, 411 to Semester I to IV (04 Credit)**

In each semester, students have to opt 02 credit courses from inter school/ NPTEL/ SWAYAM/ MOOC Online certified course (Students can opt at most 04 credits per semester and 08 credits per programme from outside the school).

**Open Elective: Soft Skill-I to IV (02 Credit)**

In each semester, students have to opt 02 credit courses from inter school. In this the open electives should be of 8 credits in a two year program (average of 4 credits each year). It is recommended that the open electives shall be of outside the parent school i.e. Inter school. This includes Credit Transfer from recognized online courses like SWAYAM/ MOOCs/ NPTEL/Skill oriented courses.

**Open Electives for other School students: STATOE01 to STATOE 04 (02 Credit)**

In each semester, students can opt 02 credit course from other programme (intra/inter) school. Students can opt any one open elective soft skill course among STATOE01 and STATOE02 at odd semesters (I/III) and among STATOE03 and STATOE0 4 at even semester (II/IV).

**NOTE:**

- Each semester will have Five (four core and one elective) Theory papers and each theory paper will be of 100 Marks [50 External Exam+ 50 Internal Exam (02 tests each of 15 Marks+20 Marks for Class performance/Assignments/Seminars etc.).]
- Each semester student should select one elective theory paper with their respective semester's Elective Group.
- In I to IV Semester, Soft Skill course (Open Elective) will be of 50 marks [25 Internal Exam+ 25 External Exam].

- All the Practical, Soft Skill and Seminar courses are compulsory to all the students.
- Each semester is of 625 marks.
- Total marks for I sem+ II sem+ III sem + IV sem = 2500.
- Total degree is of 2500 Marks, converted in the form of 100 credits CBCS system.
- One credit is of 25 marks.
- Minimum 40% Marks are required for passing in each of the above head i.e. separate passing in External Exam and that in Internal Exam.
- Project/ Practical will be evaluated by one external examiner and one internal examiner.
- Project work will commence from 3<sup>rd</sup> semester. (i) Project carrying 75 marks and it is to be given at the beginning of Semester-III and evaluated at the end of Semester-IV.
- Project batch is of minimum 02 and maximum 05 students.
- In paper STATE105 i.e. in Statistical Computing EDA using R software will be taken.
- In STATC302 and STATC402 papers i.e. Operations Research I & II TORA software and Solver tool pack will be used for practical purpose.

## M.Sc. (Statistics)-I year (First Semester) (CBCS Pattern)

### SEMESTER-I

Sr. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks @ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
STATC 101	Core I	Real Analysis	L/T	4	100	50	50	100
STATC 102	Core II	Linear Algebra	L/T	4	100	50	50	100
STATC 103	Core III	Distribution Theory	L/T	4	100	50	50	100
STATC 104	Core IV	Sampling Methods	L/T	4	100	50	50	100
STATE105	Elective - Gr I (04 Credit)	Statistical Computing (R Programming)	L/T	4	100	50	50	100
STATE106		Computer Graphics	L/T	4	100	50	50	100
STATE107		Statistics Education and Research Methodology	L/T	4	100	50	50	100
STATE108		04 Credit Course from intra School	L/T	4	100	50	50	100
STATE109		04 Credit Course from inter School/ NPTEL/SWAYAM/ MOOC Online certified course etc.	L/T	4	100	50	50	100
Elective (02 credit)	ELE-1 Select any one (Intra/Inter) Soft Skill I		L/T	2	50	25	25	50
STATPC 01	Core Practical I	Practical-I (based on STATC 101 to 104)	P	3	75	--	75	75
		<b>Total</b>						<b>625</b>

**Note:**

- STATC 105 Statistical Computing (R Programming) course (04 credits) is offered for Intra School students.

## STATC 101

## REAL ANALYSIS (Maximum no. of periods = 60)

- **Course objectives:** The aim of the course is to introduce fundamental concept of real analysis such as sequence, series of real numbers and their convergence, continuity, differentiability of real valued functions.
- **Prerequisites:** This paper requires basics of set theory.
- **Course Outcomes:**  
After completion of the course students will able to:  
**CO1:** Apply fundamental concepts of Real Analysis.  
**CO2:** Define and recognize sequence, series of real numbers.  
**CO3:** Understand and recognize various continuous and discontinuous functions  
**CO4:** Gain the knowledge about differentiability of real functions and to apply related theorems to solve various examples.

**Unit I:** Countability, supremum and infimum of sets of real numbers. Archimedean property, denseness property of rationals. Metric spaces, limit points and interior points of a set, open sets, closed sets etc. (12L + 3T)

**Unit II:** Compactness, Bolzano-Weierstrass theorem, Heine-Borel Theorem. Sequences of real numbers, Cauchy sequence, limit superior, limit inferior, limit and convergence of a sequence of real numbers. Cauchy criterion for convergence. Completeness of  $\mathbb{R}$ . (12L + 3T)

**Unit III:** Series of real numbers, convergence of series, tests for convergence of series, absolute convergence, Cauchy product of two series and its convergence. Power series and radius of convergence, examples and problems on these concepts. (12L + 3T)

**Unit IV:** Continuous functions, uniform continuity, uniform convergence of sequences and series of functions, term by term differentiation and integration, applications to power series. (12L + 3T)

### REFERENCES:

- 1) Apostol T.M.(1985) Mathematical Analysis, Narosa, Indian Ed.
- 2) Courant R. And John F.(1965) Introduction to Calculus and Analysis, Wiley.
- 3) Miller K.S.(1957) Advanced Real Calculus, Harper, New York.
- 4) Rudin, Walter(1976) Principles of Mathematical Analysis, McGraw Hill.
- 5) Malik S.C.(2005) Principles of Real Analysis, New Age International (p)Ltd.
- 6) Bartle R.G.(1976) Elements of Real Analysis, Wiley.

## STATC 102

## LINEAR ALGEBRA

(Maximum no. of periods = 60)

- **Course objectives:** To learn the basic ideas of abstract algebra and techniques with proof in pure mathematics and further, it can be use in many other courses.
- **Prerequisites:** This paper requires basic of vector spaces.
- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Use the basic concepts of vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity, for analysis of matrices and systems of linear equations.

**CO2:** Evaluate determinants and use them to discriminate between invertible and non-invertible matrices; Use the characteristic polynomial to compute the eigen values and eigenvectors of a square matrix and use them to diagonalizable matrices when this is possible.

**CO3:** Discriminate between diagonalizable and non-diagonalisable matrices; orthogonally diagonalizable symmetric matrices and quadratic forms.

**CO4:** Combine methods of matrix algebra to compose the change-of-basis matrix with respect to two bases of a vector space, identify linear transformations of finite dimensional vector spaces and compose their matrices in specific bases.

**UNIT I:** Vector spaces: Vector spaces, subspaces, span of a set, linear dependence, independence, Dimension and Basis. Linear Transformation: Range and kernel of a linear map, Rank and Nullity, Inverse of linear transformation, Rank Nullity theorem, the space  $L(U, V)$ . (12L+3T)

**UNIT II:** Matrices and Determinants :Linear map associated to matrix , matrix associated with linear map, Matrix multiplication, Rank and Nullity of matrix, Transpose of matrix, Elementary row operations, System of linear equations, Matrix inversion, Properties of determinants, Eigen values and Eigen vectors, algebraic multiplicity and geometric multiplicity, Cayley Hamilton theorem, Minimal polynomial. (12L+3T)

**UNIT III:** Inner product spaces and Quadratic forms: Inner product spaces, orthogonality, orthonormal basis, Gram Schmidt orthogonalization process, Classification of quadratic forms, rank and signature. (12L+3T)

**UNIT IV:** Canonical forms and generalized inverse: Echelon form, normal form, Hermite canonical form, Diagonalisation, Singular value decomposition, Jordan canonical form, Kroneker product, generalized inverse. (12L+3T)

### Text Books:

**For units I to II** (3.1 to 3.6, 4.1 to 4.6, 5.1 to 5.9, 6.1 to 6.9)

- 1) Krishnamurthy, Mainra and Arora, An introduction to Linear Algebra, East- west press pvt. Ltd. New Delhi.

**For units III and IV** (4.4 to 4.6, 8.6 to 8.8, 7.1 to 7.6, 9.1 to 9.3)

- 2) Ramchandra Rao and Bhimasankaram, Linear Algebra, 2<sup>nd</sup> edition, Hindustan book agency (India).

### REFERENCES:

- 1) T. M. Karade and J. N. Salunke, Introductory Linear Algebra, Ist Edition 2012, Sonu Nilu Publication.
- 2) S. K. Mapa, Higher algebra Abstract and Linear, 10<sup>th</sup> edition, SARAT Book distributors, Calcutta.

- 3) Hoffman and Kunze, Linear Algebra, Prentice Hall India.
- 4) Friedberg, Insel, Spence, Linear Algebra, 4<sup>th</sup> edition, Prentice Hall India.

## STATC 103

## DISTRIBUTION THEORY

(Maximum no. of periods = 60)

- **Course objectives:**

- To present the general theory of statistical distributions as well as the standard distributions found in statistical practice.
- To train students with essential tools for statistical analyses at the post graduate level. Fostering understanding through real-world statistical applications.

- **Prerequisites:** Random experiment and its sample space, events, random variables: discrete and continuous random variables, P.d.f., P.m.f., c.d.f. of random variables, M.g.f., p.g.f. c.g.f., characteristic function of random variables, Moments.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand the most common discrete and continuous probability distributions and their real life applications.

**CO2:** Compute marginal and conditional distributions from joint distributions.

**CO3:** Get familiar with transformation of univariate and multivariate densities. Understanding of distribution helps to understand the nature of data and to perform appropriate analysis.

**CO4:** Apply compound, Truncated, mixture and non-central probability distributions to solve problems.

**UNIT I:** Standard discrete and continuous distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Poisson, Hypergeometric distributions. Exponential, Normal, Gamma, Beta, Uniform, Chi-square, Lognormal, Weibull, Cauchy distributions. M.g.f., p.g.f., c.g.f., characteristic function, Moments of above distributions. Properties of above distributions. **(12L+3T)**

**UNIT II:** Joint, Marginal and Conditional distributions, Independence of random variables. Bivariate normal distributions. Joint p.d.f., Marginal p.d.f.s, Conditional p.d.f., joint m.g.f., some properties. **(12L+3T)**

**UNIT III:** Multinomial distribution: joint p.m.f., Marginal p.m.f., Conditional p.m.f., Joint m.g.f. transformation and functions of random variables and their distributions. **(12L+3T)**

**UNIT IV:** Compound, Truncated and Mixture Distributions, Order Statistics. Non-central Chi-square, t and F-distributions and their properties. **(12L+3T)**

### REFERENCES:

- 1) Rohatgi V.K. and Ehsanes Saleh A.K.MD.(2003) An Introduction to probability theory and Mathematical Statistics, Wiley Eastern, 2nd Ed.
- 2) Hogg R.V. and Craig A.T.(1978) Introduction to Mathematical Statistics, 5th Ed. Pearson's Education.
- 3) Hogg R.V. and Tanis E.(2002) An Probability and Statistical Inference, 6th Ed. Pearsons Education.
- 4) Rao C.R.(2002) Linear Statistical Inference and its Applications, 2nd Ed., Wiley Eastern
- 5) Dudewicz E.J. and Mishra S.N.(1988) Modern Mathematical Statistics, Wiley & Sons.

### ADDITIONAL REFERENCES:



- 1) Pitman J.(1993) Probability, Narosa Publishing House.
- 2) Johnson S.and Kotz (1972)Distributions in Statistics, Vol.I,IIand III,Houghton and Miffin.
- 3) Cramer H.(1946)Mathematical Methods of Statistics, Princeton.

## STATC 104

## SAMPLING METHODS

(Maximum no. of periods = 60)

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

- **Prerequisites:** This paper requires basic of data types, organization of data, tabulation of data etc.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand the basic principles underlying survey design and estimation.

**CO2:** Apply the different sampling methods for designing and selecting a sample from a population.

**CO3:** Implement Cluster sampling, Ratio and Regression estimation in real life problems.

**CO4:** Apply unequal probability sampling designs viz. PPSWR, PPSWOR including Lahiri's method and Murthy's estimator for survey.

**UNIT I:** Concept of population and sample, need for sampling, Census and sample surveys, basic concepts in sampling and designing of large-scale survey design, sampling scheme and sampling strategy. Sampling and Non-sampling errors, Response and non-response errors. Basic methods of sample selection: SRSWR, SRSWOR. **(12L+3T)**

**UNIT II:** Stratified sampling: Formation of strata and number of strata, Allocation problems and estimation problems, cost and variance analysis. Systematic sampling and related results on estimation of population total, mean and proportion. **(12L+3T)**

**UNIT III:** Cluster sampling, Estimator of population mean and its properties. Two-stage sampling. Double sampling. Ratio and Regression estimators and their properties and MSEs. Unbiased and almost Unbiased ratio type estimators. **(12L+3T)**

**UNIT IV:** Unequal Probability Sampling Designs: Inclusion probabilities, Horwitz - Thompson estimator and its properties. PPSWR, PPSWOR methods (including Lahiri's scheme) and related estimators of a finite population mean (Heansen-Horwitz and Desraj estimators for a general sample size and Murthy's estimator for a sample of size, Midzuno sampling design). **(12L+3T)**

### REFERENCES:

- 1) Chaudhari A. And Mukerjee R. (1988) Randomized Response: Theory and Techniques, New York, Marcel Dekker Inc.
- 2) Cochran W.G.(1984) Sampling Techniques, Wiley.
- 3) Des Raj and Chandok(1999)Sample Survey Theory, Narosa.
- 4) Murthy M. N.(1977) Sampling Theory and Methods, Statistical Pub.Society, Calcutta.
- 5) Sukhatme P.V., Sukhatme B.V. and Ashok C.(1984)Sampling Theory of Surveys

- with Applications, Iowa state University Press and IARS.
- 6) Singh D. and Chaudhary F. S. (1986) Theory and Analysis of Sample Survey Designs, New Age International Publishers.
- 7) Mukhopadhyay P.(2002) Theory and Methods of Sample Survey, Chpman and Hall.

## STATE105                      STATISTICAL COMPUTING

(Maximum no of periods: 60)

- **Course objectives:**
- To familiar and to develop learning mindsets to analyze statistical data through R software.
- To learn basic syntax, coding and vocabulary to aid in data analysis.
  
- **Prerequisites:** Basics of descriptive statistics, probability distributions, statistical inference and basic of computer fundamentals etc.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Get familiar with R software and learn basics of R with descriptive statistics. Access online resources for R and import new function packages into the R workspace. Import, review, manipulate and summarize data-sets in R.

**CO2:** Compute probabilities and fitting of probability distribution with R environment.

**CO3:** Explore small and large data-sets to create testable hypotheses and identify appropriate statistical tests.

**CO4:** Perform correlation, regression analysis and appropriate statistical tests for real life situations using R.

**UNIT I:** Introduction: History of R programming, starting and ending R, R commands, Data types, Getting help in R, R use as calculator. Descriptive Statistics: Diagrammatic representation of data, measures of central tendency, measures of dispersion, measures of skewness and kurtosis. **(12L+3T)**

**UNIT II:** Probability and probability distributions: problems on finding basic probabilities, some special discrete distributions and continuous probability distributions, probabilities and inverse for various distributions, sketching graphs for various distributions. **(12L+3T)**

**UNIT III:** Statistical inference: Sampling distribution of sample means, estimation of parameters, hypothesis testing, goodness of fit tests. **(12L+3T)**

**UNIT IV:** Correlation, inference procedure for correlation coefficient, bivariate correlation, multiple correlations. Linear regression and its inference procedure. Simple optimization method. **(12L+3T)**

### REFERENCES

- 1) Normal Maltoff (2009) The art of R programming.
- 2) Purohit S. G., Gore S. D. and Deshmukh S. K. (2010) Statistics using R, Narosa.
- 3) W. John Braun, John Braun, Duncan James Murdoch (2007) First Course in Statistical

Programming with R, Cambridge University Press.

- 4) M. D. Ugarte, A. F. Militino, A. T. Arnholt (2008) Probability and Statistics with R, CRC Press.
- 5) Peter Dalgaard (2008) Introductory Statistics with R, Springer.
- 6) Michael J. Crawley (2007) The R Book, John Wiley and Sons.

## STATE106

## COMPUTER GRAPHICS

(Maximum no of periods: 60)

- **Course objectives:**

- To learn basic concepts used in computer graphics.
- To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping, fundamentals of animation, virtual reality and its related technologies.
- To understand a typical graphics pipeline and to design an application.

- **Prerequisites:** Basics of hardware and software of computer, MS- word, MS-paint.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand input and output devices of computer.

**CO2:** Understand how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.

**CO3:** Visualize the colors in computer graphics.

**CO4:** Comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

**Unit I:** Introduction: a) Input/output devices : Keyboard, Mouse, Trackball, Joysticks, Data Glove, Digitizers, Light pen, Touch panels, Image scanners, Printers and plotters. b) Logical Input Devices: Locator, Stroke, String, Valuator, Choice and Pick. c) Video Display Devices: Refresh Cathode-Ray Tubes, Raster-Scan Displays, Random-Scan Displays, Colour CRT Monitors, Direct-View Storage Tubes, Flat Panel Displays d) Raster-Scan Systems: Video Controller, Raster-Scan Display Processor, Random-Scan Systems. **(12L+3T)**

**Unit II:** Output Primitives: a) Line, Circle, Ellipse and Curve generation algorithm, b) Polygon filling algorithm c) Windowing and clipping : Window to Viewport transformation, line clipping and polygon clipping, B) 2D and 3D transformations : a) 2D basic transformation, other transformation, composite transformation, matrix representation and homogeneous transformation, b) 3D concepts : Display models, parallel and perspective projections c) 3D basic transformation, other transformation & composite transformation. **(12L+3T)**

**Unit III:** Colours in computer graphics: Chromatic and achromatic light, properties of light, colour lookup tables, Colour models : XYZ, RGB, CMY, HSV, HLS, B) Curve generation: a) Bezier curve, properties of Bezier curve, Cubic Bezier Curve, b) B-Spline curves : i)Uniform, Periodic B Spline, ii) Cubic, periodic B-spline, iii) Open, uniform B- Spline iv)Non-uniform B-spline, c) Beta-Spline : Beta spline continuity conditions, cubic periodic beta spline, matrix Representation, d) Introduction to fractal (Koch and Hilberts curve). **(12L+3T)**

**Unit IV:** Illumination model and shading methods: a) Basic illumination models : Ambient light, diffuse reflection, specular reflection and its Phong model, shadows and transparency, ray tracing, displaying continuous tone images, halftone pattern and Dithering techniques, aliasing and antialiasing b) Phong rendering methods: Constant intensity shading, Gouroud shading, Phong and Fast Phong shading B) Visible surface detection methods :Classification of visible surface detection algorithm, Back-face detection, depth-buffer method, A-buffer method and Painter's algorithm C) Design and implementation of Application s/w :Study of advance software platform viz. 3-D studio max, Animator Pro, Introduction to OPEN GL, comparison with the facilities provided by conventional IDEs viz. CC++, Visual computing environment. **(12L+3T)**

#### **REFERENCES:**

- 1) Donald Heran and M Pauline Baker: Computer Graphics
- 2) Roger Stevens: Advanced Graphics Programming in C and C++
- 3) F. S. Hill: Computer Graphics
- 4) Newmann Sproul: Principles of Interactive Computer Graphics
- 5) Foley J D & van Dam: Fundamentals of Interactive Computer Graphics
- 6) Plastock & Kelly: Theory and Problems of Computer Graphics
- 7) Devid rogers: Mathematical Elements of Computer Graphics
- 8) David rogers: Procedural Elements of Computer Graphics
- 9) Steven Harrington: Computer Graphics: A Programming Approach
- 10) S P Bhandari and S A Joshi: Computer Graphics

## **STATE107 STATISTICS EDUCATION AND RESEARCH METHODOLOGY** (Maximum no of periods: 60)

- **Course objectives:** To learn critical and creative thinking of model and its components of research.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand the basic of research and blooms taxonomy of learning levels.

**CO2:** Find the topics from current research in statistics education.

**CO3:** Apply statistical tools in design, research and development.

**CO4:** Understand, implement and interpreted the general and specific research patterns.

**Unit I:** Characteristics of 21st century professional – problem solver, innovator, effective communicator, collaborator, self-directed learner, information and media literate, globally aware, civically engaged, critical thinker; nature of Statistics discipline; definition and goals of Statistics education; characteristics of a good teacher, Bloom's Taxonomy of learning levels – knowledge level, comprehension, application, analysis, evaluation and synthesis; teaching statistical concepts at various levels of learning. Key verbs to test learning outcomes at various levels of learning; using computers and information technology to teach statistics – using simulations to teach statistical concepts.

**(12L+3T)**

**Unit II:** Introduction to design science and applications to designing controlled experiments, observational studies, survey instruments, preparing for statistical consultancy services- to Informal inference; statistical thinking and communication; Monitoring then effective use of statistical methods and statistical software packages, topics from current research in statistics education. **(12L+3T)**

**Unit III:** Academicians view and practitioners view of Statistics as a discipline; meaning of research; basic skills required for researching in statistics; Critical and creative reading; critical thinking and

creative thinking; types of research, a Model and its components of research; understanding the various components. **(12L+3T)**

**Unit IV:** General research patterns and research patterns specific to research in Statistics. Detailed study of various researching strategies and some illustrations, designing of instruments for research and their validation, written and oral presentation of research outcomes, physical and logical structuring of research writings, illustrations of research problems and outcomes from literature.

**(12L+3T)**

**References:**

1. Kothari C. R. (1990). Research methodology: Methods and techniques, 2<sup>nd</sup> Edn, New Age International Pub.
2. Ackoff, Russell L. (1961). The design of social research, Chicago: University of Chicago Press.
3. Ackoff, Russell L. (1962). Scientific method: New York: John Wiley and sons.
4. Kothari C. R. (1984). Quantitative techniques, Vikas Pub. House, Pvt. Ltd.
5. Gopal M. H. (1964) An introduction to research procedure in social sciences, Bombay: Asia Pub. House.

## **Core Practical-I STATPC 01 Practical-I (based on STATC 101 to 104)**

• **Course Outcomes:**

After completion of the practical students will able to:

**CO1:** Solve the real analysis problems.

**CO2:** Apply linear algebra problems in real life situations.

**CO3:** Fit the distributions to a real life data using R-software.

**CO4:** Perform sampling methods analysis using R-software.

**Structure of the course: M.A./M.Sc. (Statistics)-Second Semester (CBCS Pattern)**

**SEMESTER-II**

Sr. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks@ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
STATC 201	Core V	Probability Theory	L/T	4	100	50	50	100
STATC 202	Core VI	Regression Analysis	L/T	4	100	50	50	100
STATC 203	Core VII	Parametric Inference	L/T	4	100	50	50	100
STATC 204	Core VIII	Stochastic Processes	L/T	4	100	50	50	100
STATE 205	Elective - Gr II (04 Credit)	Calculus	L/T	4	100	50	50	100
STATE 206		Demography	L/T	4	100	50	50	100
STATE 207		Statistical Methods in Epidemiology and Ecology	L/T	4	100	50	50	100
STATE 208		Categorical Data Analysis	L/T	4	100	50	50	100
STATE 209		04 Credit Course from intra School	L/T	4	100	50	50	100
STATE 210		04 Credit Course from inter School/ NPTEL/SWAYAM /MOOC Online certified course etc.	L/T	4	100	50	50	100
Elective (02 credit)	ELE-1 Select any one (Intra/Inter) Soft Skill II	L/T	2	50	25	25	50	
STATPC 02	Core Practical II	Practical-II (based on STATC 201 to 204)	P	3	75	--	75	75
		<b>Total</b>						<b>625</b>

**Note:**

- STATE 207 Statistical Methods in Epidemiology and Ecology course (04 credits) is offered for Intra School students.

## STATC 201

## PROBABILITY THEORY

(Maximum no of periods: 60)

- **Course objectives:** To understand the uncertain occurrence situations with logical manner.
- **Prerequisites:** Basics of measure theory, real analysis, random variable, generating functions, distribution function.
- **Course Outcomes:**

After completion of the practical students will able to:

**CO1:** Recognize common probability distributions for discrete and continuous variables.

**CO2:** Apply methods from algebra and calculus to derive the mean and variance for a range of probability distributions.

**CO3:** Calculate probabilities relevant to multivariate distributions, including marginal and conditional probabilities and the covariance of two random variables.

**CO4:** Understand the concept of convergence, common methods for evaluating an inequalities performance and properties of desirable estimators. Understand the central limit theorem and large-sample approximations for common statistics.

**Unit I:** Classes of sets, fields and sigma-fields, limit of sequences of subsets, sigma- field generated by a class of subsets, Borel fields. Probability measure on a sigma-field, probability space, continuity of a probability measure, other measures. Real and vector-valued random variables, limits of random variables. **(12L+3T)**

**Unit II:** Distribution functions (d.f.), properties of a distribution function, discontinuous points of a distribution function, discrete and continuous random variables and vectors and their distribution functions, decomposition of a d.f., correspondence theorem. Expectation of simple random variable, non-negative and general random variables. Properties of expectation, moments. **(12L+3T)**

**Unit III:** Monotone convergence theorem, Fatou's lemma, Lebesgue dominated convergence theorem. Inequalities:  $C_r$ -inequality, Holder's, Schwarz, Minkowski, Jensen, Basic inequality. Independence of two events and  $n (> 2)$  events, sequence of independent events, independent classes of events, independence of random variables. **(12L+3T)**

**Unit IV:** Borel-Cantelli Lemma, convergence almost sure, convergence in probability, convergence in  $r$ th mean, convergence in distribution. Weak Law of Large Numbers: Chebyshev's and Kintchine's. Strong law of large numbers (without proof), Levy continuity theorem, Central limit theorem. **(12L+3T)**

### REFERENCES:

- 1) Bhat B. R. (2000) Modern Probability Theory, New age international.
- 2) Ash Robert (1972) Real analysis and probability, Academic press.
- 3) Mukhopadhy P. (2002) Theory of Probability, New central book agency, Calcutta.
- 4) Vardhan S. R. S. (2000) Probability Theory, New York University.
- 5) Billingsley P. P. (1986) probability and measure, Wiley.
- 6) Dudewicz E. J. and Mishra S. N. (1988) Modern Mathematical statistics, Wiley Int. Students Edition.
- 7) Rohatgi V. K. (1984) An introduction to probability theory and Mathematical Statistics, Wiley Eastern.

## STATC 202

## REGRESSION ANALYSIS

(Maximum no. of periods: 60)

- **Course objectives:**

- To develop a deeper understanding of the linear and non-linear regression model and its limitations.
- To learn how to develop regression model and apply for the specific perspective data appropriate manner.

- **Prerequisites:** Basics of data types, correlation, distribution of the data, and theory of estimation.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Apply simple linear regression model to real life examples.

**CO2:** Understand multiple linear regression models with applications and concept of Multicollinearity and autocorrelation.

**CO3:** Compute multiple and partial correlation and checking residual diagnostic to validate model.

**CO4:** Apply Logistic and Non-linear regression models and its implementation in real life situation.

**UNIT I:** Simple linear regression, assumptions, least square (LS) estimators of parameters, standard error of estimators, testing of hypothesis for coefficient of regression, s.e. of prediction, testing of hypotheses about parallelism (Slopes), equality of intercepts, congruence, extrapolation, optimal choice of independent variables, diagnostic checks and correction: graphical technique, tests for normality, uncorrelatedness, homoscedasticity, lack of fit, detection of outliers, Remedies. Weighted LS. **(12L+3T)**

**UNIT II:** Multiple regression: Standard Gauss-Markov setup, least square estimation, error and estimation spaces, variance and covariance of LS estimators, properties of LS estimators, testing of hypothesis for one and more than one linear parametric functions, confidence intervals Multicollinearity: Consequences, detection and remedies. Autocorrelation consequences, Durbin Watson test, estimation of parameters in autocorrelation. **(12L+3T)**

**UNIT III:** Multiple correlations, partial correlation coefficient. Test for significance of simple, multiple and partial correlation coefficients, variable selection procedures. Residual and residual diagnostics, transformation of variables: Box- Cox power Transformation, generalized weighted least sequence. Mallows Cp Statistics, forward and backward selection method. **(12L+3T)**

**UNIT IV:** Logistic regression: Logistic transform, ML estimation, tests of hypothesis, Wald test, LR test, score test, test for overall regression Ridge regression, robust regression. Non-linear regression models. **(12L+3T)**

### REFERENCES:

- 1) Joshi D.D. (1987) Linear Estimation and design and analysis of experiments, Wiley Eastern.
- 2) Giri N (1986) Analysis of variance, South Asia Publishers.
- 3) Cook R.D. And Weisberg S. (1982) Residual and influence in Regression, Chapman and Hall.
- 4) Draper N.R. and Smith, H (1998) applied Regression analysis, 3rd ed. Wiley.
- 5) Rao. C.R. (2002) Linear Statistical Inference and its Applications, 2nd Ed. Wiley.
- 6) Weisberg S. (1985) Applied Linear Regression, Wiley.



- 7) Montgomery D.C., Peck, E.A. and Vining G.G.(2003). Introduction to Linear Regression Analysis, 3<sup>rd</sup> Ed. Wiley.
- 8) Ratkowsky, D. A.(1983) Nonlinear regression modeling, Marcel Dekker.
- 9) Kutner, Neter, Nachtsheim and Wasserman (2003) Applied Linear Regression, 4<sup>th</sup> Ed., McGraw-Hill.

## STATC 203

## PARAMETRIC INFERENCE

(Maximum no of periods: 60)

- **Course objectives:**
- To derive suitable point estimators of the parameters of the distribution of a random variable and give a measure of their precision.
- To learn computational skills to implement various statistical inferential approaches.

- **Prerequisites:** Basics of descriptive statistics, probability distribution.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand the notion of a parametric models, point and interval estimation of the parameters of those models.

**CO2:** Obtain the sufficient statistic, minimal sufficient statistic, m.l.e., moment estimator of the parameter.

**CO3:** Understand the concept of MVUE, MVBUE, UMVUE.

**CO4:** Describe the concept of Bayesian inference and their real life applications.

**UNIT I:** Introduction of Parametric models, Point estimation, Interval estimation, Joint distribution of a sample and sampling distribution of a Statistic. Likelihood function; examples from standard discrete and continuous models. Information in data about the parameters and variation in likelihood function. Sufficiency, Sufficient Statistic, Neyman Factorizability criterion. Invariance property of sufficiency under one-one transformation of sample space. (12L+3T)

**UNIT II:** Likelihood equivalence, Minimal sufficient Statistic. Ancillary Statistic, Exponential families and Pitman families. Fisher information for one and several parameters models. Maximum Likelihood methods, Methods of moments. (12L+3T)

**UNIT III:** MVUE, MVBUE, UMVUE, Rao-Blackwell theorem and its applications. Completeness property of family of distributions. Lehmann-Scheffe theorem, Necessary and sufficient condition for UMVUE. Cramer-Rao lower bound approach. (12L+3T)

**UNIT IV:** Introduction to Bayesian estimation, prior & posterior distribution, loss function, principle of minimum expected posterior loss, quadratic & other common loss functions, conjugate family of prior distribution & its examples. (12L+3T)

### REFERENCES:

- 1) Kale B.K. (1999) A First course on Parametric Inference, Narosa.
- 2) Casella G. & Beregar R.L.(2002) Statistical Inference, 2nd edition, Duxbury Advanced series.
- 3) Ferguson T.S (1996): A course on large sample Theory, Chapman and Hall.
- 4) Dudewitz E.J. & Mishra S.N.(1988) Modern mathematical Statistics, JohnWiley.

- 5) Lehman E.L. (1988) Theory of point estimation, John Wiley.
- 6) Lehman E.L. (1986) Testing of statistical hypotheses, John Wiley.
- 7) Rohatgi V.K and Saleh A.K. Md. E (2001) Introduction to Probability Theory and Mathematical Statistics, John –Wiley and Sons.
- 8) Rao C. R.(1973) Linear Statistical Inference & its Applications, 2nd Ed., Wiley.
- 9) George Casella, Roger L. Berger (2001) Statistical Inference,2nd Ed., Duxbury press.
- 10) Zacks S. (1971) Theory of Statistical Inference John Wiley and Sons, New York.

## STATC 204

## STOCHASTIC PROCESSES

(Maximum no. of periods = 60)

- **Course objectives:**
- To learn and to understand stochastic processes predictive approach.
- To develop an ability to analyze and apply some basic stochastic processes for solving real life situations.
- **Prerequisites:** This paper requires basics of exploratory data analysis, data types, basic probability etc.
- **Course Outcomes:**  
After completion of the course students will able to:
  - CO1:** Understand the stochastic processes, Markov chains, Transition probability matrix and various types of states.
  - CO2:** Explain Random walk, Gambler ruins problem and apply Poisson process in real life situations.
  - CO3:** Formulate and solve problems which involve setting up stochastic models.
  - CO4:** Understand renewal theory and branching processes with applications.

**Unit I:** Introduction to stochastic Processes (SP's) Classification of SP's according to State space & time domain. Markov chain, countable state Markov chain, calculation of n-step transition probability & its limit. Chapman-Kolmogorov equation, Stationary distribution, classification of states, criteria for various states, Ergodic theorem. (12L+3T)

**Unit II:** Random walk & gambler's ruin problem, absorbing and reflecting barriers, probability of eventual absorption, expected duration of game, random walk in 2 & 3 dimension. First passage time distribution. Poisson process, properties of Poisson process. (12L+3T)

**Unit III:** Discrete state space & continuous time Markov chain, pure birth, pure death, Birth and death process. Continuous state space, continuous time Markov chain, Wiener process, Wiener process as a limit of random walk, differential equation of Wiener process, first passage problem in Wiener process. (12L+3T)

**Unit IV:** Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application. Galton-Watson Binaymi Branching process. Probability of ultimate extinction. Stationary Process: Weak Stationary and strong stationary processes. (12L+3T)

### REFERENCES:

- 1) Medhi, J. (1994) Stochastic Processes, Wiley Eastern.
- 2) Bhat, B. R. (2000) Stochastic Models: Analysis and Applications, New Age International, India.

- 3) Adke, S. R. and Manjunath, S.M. (1984) An Introduction to finite Markov Processes, Wiley Eastern.
- 4) Parzen E. (1962) Stochastic Process, Holden-Pay.
- 5) Karlin & Taylor, A. (1975) First Course in Stochastic Process, (Vol.1) Academic Press.
- 6) Cinlar E.(1975) Introduction to Stochastic Process, Prentice Hall.
- 7) Srinivas and Mehta (1976) Stochastic Processes, Tata McGraw Hill, New Delhi.
- 8) Feller, W.(1968) Introduction to Probability and its Applications, (Vol.1) Wiley Eastern.
- 9) Harris, T.E. (1963). The Theory of Branching Processes, (Springer-Verlag).
- 10) Hoel, P.G., Port, S. C. and Stone, C. J. (1972) Introduction to Stochastic Processes, Houghton Mifflin & Co.
- 11) Jagers, P. (1974) Branching Processes with Biological Applications, Wiley.
- 12) Ross, S. (2005) Introduction to Probability Models, 6th Ed. Academic Press.
- 13) Taylor and Karlin (1984) An Introduction to Stochastic Modeling, Aca. Press

## STATE 205

## CALCULUS

(Maximum no. of periods: 60)

- **Course objectives:**
- To compute and analyze limits, derivatives, and integrals functions.
- To recognize the appropriate tools of calculus to solve applied problems.
- **Prerequisites:** This paper requires basics of real analysis.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand the type of variable and useful in the development of the function.

**CO2:** Verify the value of the limit of a function at a point using the definition of the limit.

**CO3:** Understand the consequences of the Intermediate value theorem for continuous function.

**CO4:** Know the chain rule and use it to find derivatives of composite functions and obtain expression for higher order derivatives of a function using the rule of differentiation. Solve integrals and evaluation of multiple integrals with numerical problems.

**Unit I:** Derivatives: Introduction, Definition of derivative, Derivatives and continuity, Algebra of derivatives, The chain rule, One-sided derivatives and infinite derivatives, Functions with nonzero derivatives, Zero derivatives and local extrema. **(12L+3T)**

**Unit II:** Rolle's theorem, The Mean-Value Theorem for derivatives, Intermediate-Value theorem for derivatives Taylor's formula with remainder, Partial derivatives, The directional derivative, Directional derivatives and continuity, The total derivative, The total derivative expressed in terms of partial derivatives. **(12L+3T)**

**Unit III:** The matrix of a linear function, The Jacobian matrix, The chain rule, The Mean-Value Theorem for differentiable functions, A sufficient conditions for differentiability, A sufficient condition for equality of mixed partial derivatives, Functions with nonzero Jacobian determinant. **(12L+3T)**

**Unit IV:** The inverse function theorem(statement only), The implicit function theorem(statement only), Extrema of real-valued functions of one variable, Extremum of real-valued functions of several

variables, Extremum problems with side conditions, Line integrals, Line integrals independent path, Double integrals, Triple integrals. (12L+3T)

**Text Book:** 1) Apostol Tom. M.-Mathematical Analysis: A modern approach to Advanced calculus.(Addison-Wesley)

2) Kreyszig,E. Advanced Engineering Mathematics(Wiley Eastern)

**Scope:** Book 1 : Ch 5: 5.1 to 5.14 Ch 12 : 12.1 to 12.5 12.8 to 12.13  
Ch 13 : 13.1 to 13.7

**Book 2:** Ch 9 : 9.1,9.2, 9.3,9.7

**Reference Books:**

1. Bartle, R.G. Elements of Real Analysis(John Wiley)
2. Rudin, W. Principles of Mathematical Analysis(McGraw-Hill)

## STATE 206

## DEMOGRAPHY

(Maximum no of periods: 60)

- **Course objectives:**

- To identify appropriate sources of data and to perform basic demographic analyses using various techniques across populations.
- To learn the main theories used to understand population studies and societal change.

- **Prerequisites:** Descriptive statistics, Index number, Graphical representation of data.

- **Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand the interdisciplinary nature of demography, balancing equation, use of Whipple's, Myers and UN indices.

**CO2:** Understand the measures of mortality and fertility.

**CO3:** Describe the concept of life tables.

**CO4:** Apply Quasi, Lotka's stable population models.

**Unit I:** Demography and its interdisciplinary nature, sources of demographic data, Coverage and Content errors. The use of balancing equation, Chandrasekaran and Deming formula to check completeness of registration data. Use of Whipple's Myers's and UN Indices.

(12L+3T)

**Unit II:** Measures of Mortality : Various measures of mortality, infant mortality rate, cause specific death rates and standardized death rates . Measures of Fertility: Period and cohort fertility measures, use of birth order statistics, child-women ratio, Brass P/F ratio to estimate current level of fertility, Measures of reproduction and replacement. Sheps and Perrin stochastic human reproductive process.

(12L+3T)

**Unit III:** Life Tables : Types of life tables, inter-relationships between life table functions, construction of life tables using Reed- Meerel and Greville's Method. Probability distribution of life table functions and their optimum properties. Population estimation and Projection: Mathematical , Statistical and Demographic Methods, Component method.

(12L+3T)

**Unit IV:** Stable and Quasi – stable population: Derivation of Lotka's stable population model and properties, Intrinsic growth rate and derivation, age structure and birth rate of a stable population, mean length of generation, momentum of population growth, Quasi-stable population under changing fertility and mortality situations .

(12L+3T)

**References:**

- 1) Shryoch, Henry S, Jacob S, Siegel and Associates (1964)-Methods and materials of demography (condensed edition) Academic press, London.
- 2) Barclay, George W. (1968) Techniques of population analysis, John Wiley and sons, New York.
- 3) Keyfitz N. (1968) Introduction to Mathematics of Population. Addison-Wesley Publishing Co, Reading, Massachusetts.
- 4) Chiang C.L. (1968) Introduction to stochastic processes in Biostatistics, John Wiley and sons, New York.
- 5) R. Ramkumar (1986) Technical Demography, Wiley Eastern, New Delhi.
- 6) Sudhendu Biswas (1988), Stochastic processes in Demography and Applications, Wiley Eastern, New Delhi

**STATE 207 STATISTICAL METHODS IN EPIDEMIOLOGY AND ECOLOGY**

(Maximum no of periods: 60)

**• Course objectives:**

- To learn different methods of carrying out and analysing, epidemiological studies.
- To study pertinent issues such as appropriate design, data quality, analysis, and interpretation and presentation of results in environmental studies.

- **Prerequisites:** Basics of data types, organization and tabulation of data etc. Much of this course deals with extensions of regression modelling to handle categorical response variables, so students should be comfortable with multiple regression modeling.

**• Course Outcomes:**

After completion of the course students will able to:

**CO1:** Understand the basic epidemiology, parametric growth models and single species growth models.

**CO2:** Understand effect of measurement errors on growth rate and related inference problems.

**CO3:** Understand the concept of demographic and environmental stochasticity.

**CO4:** Understand mathematical models of infectious diseases in stochastic environment.

**Unit I:** Introduction to dynamical models in ecology and epidemiology, Introduction to parametric growth models, Single species growth models -exponential, logistic, extended logistic, Gompertz etc.: notion of density dependent and independent growth, asymmetry in growth dynamics, the notion of growth rate metric and its extension, distribution of growth rate and its asymptotics.. **(12L+3T)**

**Unit II:** Effect of measurement errors on growth rate and related inference problems, longitudinal data and growth curve analysis, goodness-of-fit test for growth curve models, profile likelihood, nonlinear growth models and asymptotics, resampling techniques in growth curves. Stochastic extension of growth models. **(12L+3T)**

**Unit III:** Concept of demographic and environmental stochasticity, notion of stochastic stability and related statistical diagnostics in population dynamics. Concepts of equilibrium and quasi equilibrium distribution and its moments, concept of Allee effects and association extinction dynamics, simple extension to interactive population dynamics. **(12L+3T)**

**Unit IV:** Mathematical models of infectious disease in stochastic environment, concept of stochastic SI, SIR, SIS epidemic models, estimation of basic reproduction number and time to extinction of disease, likelihood based inferences. . (12L+3T)

**References:**

**Texts:**

1. Growth Curve modelling: Theory and Applications by Michael, J. , Panik, Wiley, 2015.
2. A primer in ecology with R by M. Henry H. Stevens, Springer, 2009.
3. Ecological Models and Data in R by Benjamin M. Bolker, Princeton university press, 2006
4. Allee effects in Ecology and Conservation by F. Courchamp, L. Berec, and J. Gascoigne, 2008.
5. Statistical Ecology: A primer in methods and computing by Ludwig and Reynolds, John Wiley and Sons 1988.
6. Nonlinear Regression by Seber and Wild, Wiley series in probability and statistics, 2003

**STATE 208**

**CATEGORICAL DATA ANALYSIS**

(Maximum no of periods: 60)

- **Course objectives:**
  - To study distributions for categorical data.
  - To describe and make statistical inference for contingency tables.
  - To learn different models for categorical data such as Generalized Linear, logit, logistic, log linear and matched pair models.
- **Prerequisites:** This paper requires basic of data types, organization of data, tabulation of data etc.
- **Course Outcomes:**
  - After completion of the course students will able to:
  - CO1:** Visualize categorical data, compute measures of association and structural models for discrete data.
  - CO2:** Fit logistic models and Poisson models to data set.
  - CO3:** Check model assumptions and analyze residuals and goodness-of-fit, Conduct inference for model parameters.
  - CO4:** Understand path and structural equation modeling.

**Unit I:** Visualizing Categorical data. Measures of association. Structural models for discrete data in two or more dimensions. Estimation in complete tables. Goodness of fit, choice of a model. (12L+3T)

**Unit II:** Generalized Linear Model for discrete data, Poisson and Logistic regression models. Log-linear models. Odds-ratio. (12L+3T)

**Unit III:** Product multinomial to model sampling from multiple populations. Elements of inference for cross classification tables. Chi-square approximation for various goodness-of-fit statistics, Models for nominal and ordinal response. (12L+3T)

**Unit IV:** Path models and Structural Equations Modelling.

**(12L+3T)**

**References:**

- 1) Agresti, An Introduction to Categorical Data Analysis Wiley 2007
- 2) Bilder and Loughlin, Analysis of Categorical data with R, Chapman and Hall/CRC 2014\
- 3) Kateri, Contingency Table Analysis, Springer 2014
- 4) Dobson and Barnett: An Introduction to Generalized Linear Models, Chapman & Hall/CRC 2008
- 5) Hosmer, Lemeshow and Sturdivant, Applied Logistic Regression, Wiley 2013

**Core Practical-II STATPC-02 Practical-II(based on STATC 201 to 204)**

• **Course Outcomes:**

After completion of the practical students will able to:

**CO1:** Solve the problems related to distribution function.

**CO2:** Apply regression analysis technique real life problems.

**CO3:** Estimate the parameter of a distribution from sample.

**CO4:** Obtain the TPM of real life problems and give conclusions.

**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY  
NANDED**

**Choice Based Credit System (CBCS) Course Structure  
Soft Skill Elective Course: Semester-I/III**

**STATOE01**    **DATA ANALYSIS WITH ADVANCED EXCEL  
(02 Credit Course)**

- **Course objectives:** To learn analysis of various kinds of data using excel.
- **Prerequisites:** Descriptive statistics, data tabulation and representation, introduction of elementary MS-Excel.

- **Course Outcomes:**

After completion of the project students will able to:

**CO1:** Handle and process the data using excel.

**CO2:** Perform the analysis with analysis tool pack in excel.

**CO3:** Customize menus and toolbars in excel.

**CO4:** Understand and apply various functions available in excel.

**UNIT I:** introduction, using excel lists, creating a list, sorting, to perform a simple sort. Data forms: adding data using the data form, finding records using criteria filtering data, auto-filter, advanced filters. Totals and subtotals total row, subtotals, managing windows, multiple windows splitting windows, linking data, analysis tool pack. Analysis by goal seeks and pivot tables.

**UNIT II:** customizing menus and toolbars debugging, handling errors, macros, customizing menus and toolbars, writing macros, selecting cells and ranges, arguments and functions, loops and logic, debugging, handling errors, event-handling, menus and toolbars, working across applications, crib sheet.

**REFERENCES:**

- 1) Learn Excel 2016 Expert Skills with The Smart Method: Courseware Tutorial teaching Advanced Techniques, Mike Smart
- 2) Advance Excel 2016 Training Guide by Rita Arora
- 3) Microsoft Excel Data Analysis and Business Modeling, Wayne Winston.
- 4) Six Sigma Statistics with EXCEL and MINITAB, Issa Bass



**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY  
NANDED  
Choice Based Credit System (CBCS) Course Structure  
STATISTICS  
Soft Skill Elective Course: Semester-I/III**

**STATOE02**

**STATISTICAL ANALYSIS USING R  
(02 Credit Course)**

- **Course objectives:** To learn the statistical analysis using 'R' free and open source software.
- **Prerequisites:** Basics of descriptive and inferential statistics, distribution theory.
- **Course Outcomes:**

After completion of the project students will able to:

**CO1:** Understand basics of R environment.

**CO2:** Perform various operations on data in R.

**CO3:** Do descriptive statistical analysis in R.

**CO4:** Compute correlation and regression lines through R.

**UNIT I:** Introduction to R programming, starting and ending R; Data types; Getting help in R; R use as calculator. Simple manipulations; numbers and vectors; objects, their modes and attributes; ordered and unordered factors; arrays and matrices; list and data frames; reading data from files; grouping; loops and conditional execution.

**UNIT II:** Descriptive Statistics: Graphical procedures and diagrammatic representation. Measures: central tendency, dispersion, skewness and kurtosis. Correlation: inference procedure for correlation coefficient, bivariate correlation, multiple correlations. Linear regression: inference and its validation, polynomial regression, multiple regressions.

**References:**

- 1) Normal Maltoff (2009) The art of R programming.
- 2) Purohit S. G., Gore S. D. and Deshmukh S. K. (2010) Statistics using R, Narosa.
- 3) W. John Braun, John Braun, Duncan James Murdoch (2007) First Course in Statistical
- 4) Programming with R, Cambridge University Press.
- 5) M. D. Ugarte, A. F. Militino, A. T. Arnholt (2008) Probability and Statistics with R,
- 6) CRC Press.
- 7) Peter Dalgaard (2008) Introductory Statistics with R, Springer.
- 8) Michael J. Crawley (2007) The R Book, John Wiley and Sons.
- 9) Rizzo, M. L., Statistical Computing with R. Chapman & Hall.

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**Choice Based Credit System (CBCS) Course Structure  
Soft Skill Elective Course: Semester-II/IV**

**STATOE03**

**INTRODUCTION TO DATA MINING  
(02 Credit Course)**

- **Course objectives:** To learn basic data mining techniques and their handling using R software.
- **Prerequisites:** Basics of Descriptive and Inferential statistics, distribution theory and basics of R software.

- **Course Outcomes:**

After completion of the project students will able to:

**CO1:** Understand fundamentals of data mining.

**CO2:** Know feature and applications of data mining.

**CO3:** Understand data warehousing, OLAP, OLTP, Data visualization.

**CO4:** Implement and interpret the results of data scientifically using R software.

**UNIT I:** Fundamentals of data mining, Data mining strategies Popular Data mining techniques, Challenges of data mining, features and applications.

**UNIT II:** Data, information and knowledge, Types of Data, Data Warehouses, Data processing, Data cleaning, Data transformation, Data quality measure, OLAP: Data sampling Data Visualization, Data Filtering, Selecting attributes, Data mining estimation task: Scatter plots and correlation, Linear regression models, Logistic regression, Regression analysis using R software.

**REFERENCES:**

- 1) Instant Weka How-to by Botjan Kalua
- 2) Data Analysis with Open Source Tools: A Hands-On Guide for Programmers and Data Scientists by Philipp K. Janert
- 3) Exploring Geological Data with Weka, CoDaPack, and iNZight: Graphical Instructions.

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**Choice Based Credit System (CBCS) Course Structure  
Soft Skill Elective Course: Semester-II/IV**

**STATOE04                      DATA ANALYSIS USING SPSS SOFTWARE  
(02 Credit Course)**

- **Course objectives:** To learn statistical techniques and their implementation using comprehensive SPSS software.
- **Prerequisites:** Descriptive and Inferential statistics.
- **Course Outcomes:**  
After completion of the project students will able to:  
**CO1:** Get familiar with SPSS software and understand SPSS environment.  
**CO2:** Create and edit the data files, plot graphs using SPSS.  
**CO3:** Compute descriptive statistics using SPSS.  
**CO4:** Perform inferential statistical analysis through SPSS.

**UNIT I:** An Overview of SPSS: Frequently used dialog boxes, Editing output, Printing results, Creating and editing a data file. Managing Data: Listing cases, replacing missing values, computing new variables, recording variables, exploring data, selecting cases, sorting cases, merging files. Graphs: Creating and editing graphs and charts. Frequencies: Frequencies, bar charts, histograms, percentiles.

**UNIT II:** Descriptive Statistics: measures of central tendency, variability, deviation from normality, size and stability. Cross Tabulation and chi-square analysis. Correlation: Bivariate Correlation, Partial correlations and the correlation matrix. The T-test procedure: Independent–samples, paired samples, and one sample tests. The one way ANOVA procedure: One way analysis of variance. General Linear model, Simple and Multiple regression analysis.

**REFERENCES:**

- 1) SPSS Statistics for Data Analysis and Visualization by Jason Verlen, Andrew Wheeler, Jon Peck, Jesus Salcedo, Keith McCormick, John Wiley & Sons
- 2) How to Use SPSS A Step-by-Step Guide to Analysis and Evaluation 1st Edition by Brian C. Cronk.