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**NEP FYUGP CURRICULUM**  
**STATISTICS HONOURS/**  
**STATISTICS HONOURS WITH RESEARCH PROGRAMME**

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**FOR UNDERGRADUATE COURSES UNDER RANCHI UNIVERSITY, RANCHI**



Implemented w.e.f.  
Academic Session 2025-26 & onwards



**UNIVERSITY DEPARTMENT OF MATHEMATICS  
RANCHI UNIVERSITY**

Morabadi Campus, Ranchi 834008, Jharkhand. (Ph. 0651-6555611)

Dr. Abrar Ahmad, Head, Associate Professor, Ranchi University, Ranchi.

Ref:

Date: 26/08/2025

**Meeting of Board of Studies**

A meeting of Board of Studies was convened in the office of the Head of University Department of Mathematics, Ranchi University, Ranchi on 26/08/2025 at 02:30 PM.

The agenda of the meeting was to approve the draft syllabus of FYUG Program in Statistics & NEP Post Graduate in Statistics under Ranchi University, Ranchi.

After detailed discussion, the Board of Studies have finalized and approved the draft syllabus of FYUG Program in Statistics & NEP Post Graduate in Statistics under Ranchi University, Ranchi.

**Chairman:**

1. Dr. Abrar Ahmad  
Head University Department of Mathematics  
Ranchi University, Ranchi.

**2. External members:**

- i. Dr. Vanshi Dhar  
Retired Prof in Statistics, BAU, Ranchi
- ii. Dr. K. B. Panda  
Prof in Statistics, Department of Statistics, C.U.J. Ranchi
- iii. Dr. Sunit Kumar  
Associate Professor in Statistics  
Central University of South Bihar, Gaya.
- iv. Dr. Raman Kumar Das, Associate Professor  
Department of Mathematics, St. Xavier's College, Ranchi
- v. Prof P.K. Singh, Assistant Professor  
Department of Statistics  
Jamshedpur Cooperative College, Kolhan University, Chaibasa.
- vi. Dr. Shivam Mishra, Assistant Professor  
Department of Agricultural Statistics  
Birsa Agricultural University, Ranchi
- vii. Mr. Rakesh Mishra, Assistant Professor  
Department of Mathematics & Statistics, St. Xavier's College, Ranchi.

**3. Internal Members:**

- i. Dr. Ashish Kumar Jha  
University Department of Mathematics, Ranchi University, Ranchi
- ii. Mrs. Rimil Nidhi Bhuinyan  
University Department of Mathematics, Ranchi University, Ranchi
- iii. Dr. Sheet Nihal Topno  
University Department of Mathematics, Ranchi University, Ranchi
- iv. Mr. Amit Bara  
University Department of Mathematics, Ranchi University, Ranchi

Dr. Abrar Ahmad  
Chairman  
Univ. Department of Mathematics  
Ranchi University, Ranchi

Head  
Department of Mathematics,  
Ranchi University, Ranchi

**Approval by the Members of the NEP Implementation and Monitoring Committee of Ranchi University, Ranchi**

The Curriculum of Bachelor's Degree (Honours)/ (Honours with Research) has been approved by the NEP Implementation and Monitoring Committee of R.U., duly forwarded by the Head of the Department; it will be offered to the students of the 4-year Undergraduate Programme (FYUGP). It is implemented from the 1st Semester of the Academic Session 2025-26 and onwards.

Raj Kr Singh  
10/9/25

10/09/25

10/9/2025

Anushka Rani  
10/09/2025

10/09/25

10/9/25

10/9/25

10/9/25

10/09/2025

10/09/2025

10/09/2025

**Member Secretary**

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## HIGHLIGHTS OF FYUGP CURRICULUM

### PROGRAMME DURATION

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- The session shall commence from the **1<sup>st</sup> of July**.

### ELIGIBILITY

- The selection for admission will be primarily based on the availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in the Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if the Marks of the Major subject is not available. Reservation norms of the Government of Jharkhand must be followed as amended in times.
- UG Degree Programmes with Double Major shall be provided only to those students who secure a minimum of 75% overall marks or 7.5 CGPA or higher.
- Other eligibility criteria, including those for multiple entry, will be in light of the UGC Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions.

### ADMISSION PROCEDURE

- The reservation policy of the Government of Jharkhand shall apply in admission and the benefit of the same shall be given to the candidates belonging to the State of Jharkhand only. The candidates of other states in the reserved category shall be treated as General category candidates. Other relaxations or reservations shall be applicable as per the prevailing guidelines of the University for FYUGP.

### VALIDITY OF REGISTRATION

- Validity of a registration for FYUGP will be for a maximum of **Seven years** from the date of registration.

### ACADEMIC CALENDAR

- An Academic Calendar will be prepared by the University to maintain uniformity in the UG Honours/ Honours with Research Programmes and PG Diploma Programmes, running in the colleges under the university (Constituent/Affiliated).
- **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
- **Semester:** The Odd Semester is scheduled from **July to December**, and the Even Semester is from **January to June**. Each week has a minimum of 40 working hours spread over 6 days.
- Each semester will include Admission, coursework, conduct of examination and declaration of results, including semester break.
- To undergo an 8-week summer internship/ apprenticeship during the summer camp, the Academic Calendar may be scheduled for academic activities as below:
  - a) **Odd Semester: From the first Monday of August to the third Saturday of December**
  - b) **Even Semester: From the first Monday of January to the third Saturday of May**
- An academic year comprising 180 working days in the least is divided into two semesters, each semester having at least 90 working days. With six working days in a week, this would mean that each semester will have  $90/6 = 15$  teaching/ working weeks. Each working week will have 40 hours of instructional time.
- Each year, the University shall draw out a calendar of academic and associated activities, which shall be strictly adhered to. The same is non-negotiable. Further, the Department will make all reasonable endeavours to deliver the programmes of study and other educational services as mentioned in its Information Brochure and website. However, circumstances may change, prompting the Department to reserve the right to change the content and delivery of courses, discontinue or combine courses and introduce or withdraw areas of specialization.

### PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry

options within this period, with appropriate certifications such as:

- UG Certificate after completing 1 year (2 semesters) of study in the chosen fields of study, provided they complete one vocational course of 4 credits during the summer vacation of the first year or internship/ Apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semesters.,
- UG Diploma after 2 years (4 semesters) of study diploma provided they complete one vocational course of 4 credits or internship/ Apprenticeship/ skill based vocational courses offered during the first year or second year summer term, in addition to 9 credits from skill-based courses earned during the first, second, and third semester.
- Bachelor's Degree after a 3-year (6 semesters) programme of study,
- Bachelor's Degree (Honours) after a 4-year (8 semesters) programme of study.
- Bachelor's Degree (Honours with Research) after a 4-year (8 semesters) programme of study to the students undertaking a 12-credit Research component in the fourth year of FYUGP.

### CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over a semester (minimum 15 weeks).

- a) One hour of teaching/ lecture or two hours of laboratory /practical work will be assigned per class/interaction.
 

|                                  |   |
|----------------------------------|---|
| <b>One credit for Theory</b>     | = <u>15 Hours of Teaching</u>             |
| <b>One credit for Practicum</b>  | = <u>30 Hours of Practical work</u>       |
| <b>One credit for Internship</b> | = <u>02 Weeks of Practical experience</u> |
- b) For credit determination, instruction is divided into three major components:
 

**Hours (L)** – Classroom Hours of one hour duration.

**Tutorials (T)** – Special, elaborate instructions on specific topics of one hour duration

**Practical (P)** – Laboratory or field exercises in which the student has to do experiments or other practical work of a two-hour duration.

**Internship – For the Exit option after any academic year of a Four-year U.G. Programme for the award of U.G. Certificate, U.G. Diploma, U.G. Degree (Level 4.5, 5 or 5.5 respectively),** Students can either complete two 4-week internships worth 2 credits each or one 8-week internship for all 4 credits. This practical experience connects academic learning with real-world applications, offering valuable exposure to professional environments in their fields of study

### CHANGE OF MAJOR OR MINOR COURSES

- The change of Major or Minor courses may be allowed only once after the Second Semester and before the third Semester in the FYUG Programme, depending on the provisions laid by the FYUGP and the conditions laid by the Institution.

### CALCULATION OF MARKS FOR THE PURPOSE OF THE RESULT

- Students' final marks and the result will be based on the marks obtained in the Semester Internal Examination and End Semester Examination organized taken together.
- Passing in a subject will depend on the collective marks obtained in the Semester internal and End Semester University Examination. However, students must pass in Theory and Practical Examinations separately.

### PROMOTION CRITERIA

#### **First degree programme with a single major (160+4=164 credits):**

- i. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
- ii. No student will be detained in odd Semesters (I, III, V & VII).
- iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of the Courses in an academic year, a student has to pass in minimum 11 papers out of the total 14 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 4 papers out of 7 papers in Semester-II.



- iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum of 20 papers out of the total 26 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 6 papers in Semester-IV.
- v. To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student has to pass in minimum of 27 papers out of the total 36 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 5 papers in Semester VI.
- vi. However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

**First degree programme with dual major (192+4=196 credits):**

- i. Please refer to the FYUGP Regulations for the detailed provisions of Double Major and Dual Degrees.
- ii. No student will be detained in odd Semesters (I, III, V & VII).
- iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of the Courses in an academic year, a student has to pass in minimum 11 papers out of the total 15 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 4 papers out of 8 papers in Semester-II.
- iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum 20 papers out of the total 27 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 4 papers out of 7 papers in Semester-IV.
- v. To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student has to pass in minimum 28 papers out of the total 37 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 6 papers in Semester VI.
- vi. However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

**PUBLICATION OF RESULTS**

- The examination result shall be notified by the Controller of Examinations of the University in different newspapers and the same is to be posted also on the University website.
- If a student is found indulging in any malpractice/ unfair means during an examination, the examination taken by the student for the semester will be cancelled. The candidate has to reappear in all the papers of the session with the students of the next session, and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.
- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination to clear the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination to clear the backlog.

Regulations related to any concern not mentioned above shall be guided by the Regulations of the Ranchi University for FYUGP.

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## COURSE STRUCTURE FOR FYUGP 'HONOURS/ RESEARCH/ PG DIPLOMA'

Table 1: Credit Framework for Four-Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 164]

| Academic Level | Level of Courses  | Semester  | MJ: Discipline Specific Courses – Core or Major (80) | AC: Associated core courses from discipline/ Interdisciplinary/ vocational (8) |     | ELC: Elective courses may be opted from four paths [Follow table 2] (24) | MDC: Multidisciplinary Courses (From a pool of Courses) (9) | AEC: Ability Enhancement Courses (Modern Indian Language and English) (8) | SEC: Skill Enhancement Courses (9) | VAC: Value Added Courses (6) | IKS: (i) Indian Knowledge System (2) & SA: (ii) Social awareness (2) | RC: Research Courses (4+8)/ AMJ: Advanced Courses instead of Research (4+4+4)/ PGD: PG Diploma Level 6 (4+4+4) | Total Credits | IAP; Internship/Apprenticeship/ Project/ Vocational course/ Dissertation (4) In between Sem I to Sem-VI |     |
|----------------|---|---|--|--|-----|--|---|---|------------------------------------|------------------------------|--|--|---------------|---|-----|
|                | 1   | 2   | 3 (Major- 80)  | 4 (Minor-32)   |     |  | 5   | 6   | 7                                  | 8                            | 9  | 10   | 11            | 12  | 13  |
| Level 4.5      | Level 100-199: Foundation or Introductory courses                                   | I   | 4  | 4  | --- | ---  | 3   | 2   | 3                                  | 2                            | 2  | ---  | ---           | 20  | 4   |
|                |   | II  | 4  | ---  | 4   | ---  | 3   | 2   | 3                                  | 2                            | 2  | ---  | ---           | 20  |     |
|                |   | Exit Point: Undergraduate Certificate provided with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits) |  |  |     |  |   |   |                                    |                              |  |  |               |   |     |
| Level 5        | Level 200-299: Intermediate-level courses   | III   | 4+4  | ---  |     | 4  | 3   | 2   | 3                                  | ---                          | ---  | ---  | ---           | 20  |     |
|                |   | IV  | 4+4+4  | ---  |     | 4  | ---   | 2   | ---                                | 2                            | ---  | ---  | ---           | 20  |     |
|                |   | Exit Point: Undergraduate Diploma provided with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)     |  |  |     |  |   |   |                                    |                              |  |  |               |   |     |
| Level 5.5      | Level 300-399: Higher-level courses   | V   | 4+4+4+4  | ---  |     | 4  | ---   | ---   | ---                                | ---                          | ---  | ---  | ---           | 20  |     |
|                |   | VI  | 4+4+4+4  | ---  |     | 4  | ---   | ---   | ---                                | ---                          | ---  | ---  | ---           | 20  |     |
|                |   | Exit Point: Bachelor's Degree with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)                  |  |  |     |  |   |   |                                    |                              |  |  |               |   |     |
| Level 6        | Level 400-499: Advanced courses Hons with Research (>7.5 CGPA)/ Honours/ PG Diploma | VII   | 4+4+4  | ---  |     | 4  | ---   | ---   | ---                                | ---                          | ---  | 4  | 4             | 20  |     |
|                |   | VIII  | 4+4  | ---  |     | 4  | ---   | ---   | ---                                | ---                          | ---  | 8  | 4+4           | 20  |     |
|                |   | Exit Point: Bachelor's Degree with Honours/ Honours with Research/ PG Diploma Level 6                                       |  |  |     |  |   |   |                                    |                              |  |  |               |   | 164 |

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project.

Implemented from Academic Session 2025-26 & onwards

**Table 2: Options for Elective Minor Courses**

| <b>Path A</b>   | <b>Path B</b>   | <b>Path C</b>  | <b>Path D</b>  |
|---|---|--|--|
| <b>ELC-A;</b> Elective courses from Interdisciplinary Subjects 1 & 2 (24)   | <b>ELC-B;</b> Elective courses from discipline (24)   | <b>ELC-C;</b> Elective courses from vocational (24)  | <b>ELC-D;</b> Elective courses from discipline for Double Major (48)   |
| <p>This pathway may be recommended for students who wish to develop core competency in multiple disciplines of study. In this case, the credits for the minor pathway shall be distributed among the constituent disciplines/subjects.</p> <p>If students pursuing FYUGP are awarded a UG Degree in a Major discipline, they are eligible to mention their core competencies in other disciplines of their choice if they have earned 12 credits each from pathway courses of two particular disciplines.</p> <p>In the first three years of FYUGP, this pathway is composed of one Major discipline with 60 credits from 15 courses, and two other disciplines, with 12 credits from 3 courses in each discipline.</p> <p>In this pathway, if the students choose one of the two disciplines for 12 credits in one discipline then they should choose a different discipline for the other 12 credits.</p> <p>If the students continue to the fourth year of FYUGP, the students need to earn an additional 4 credits in both disciplines.</p> | <p>This pathway may be recommended to those students who wish for an in-depth study in more than one discipline with a focus on one discipline (Major) and relatively less focus on the other (Minor).</p> <p>If students exit at the end of the third year of FYUGP, they are awarded a Major Degree in a particular discipline and a Minor in another discipline of their choice, if they earn a minimum of 24 credits from the courses in the Minor discipline.</p> <p>If the students continue to the fourth year of FYUGP, they should earn a minimum of 32 credits in the Minor discipline, to be eligible for a UG Degree (Honours) with a Major and a Minor. For this, in the fourth year, they should earn an additional minimum of 8 credits through 2 courses in the Minor discipline.</p> | <p>This pathway may be recommended to those students who wish for exposure to a vocational discipline in addition to the in-depth study in the Major discipline.</p> <p>The credit requirements for Major and Vocational Minor disciplines in this pathway are the same as those for Major with Minor pathway, except that the Minor courses are in a vocational discipline.</p> <p>If students exit at the end of the third year of FYUGP, they are awarded a Major Degree in a particular discipline and a Minor in vocational discipline of their choice, if they earn a minimum of 24 credits from the Vocational courses.</p> <p>If the students continue to the fourth year of FYUGP, they should earn a minimum of 32 credits in the vocational discipline. For this, in the fourth year, they should earn an additional minimum of 8 credits through 2 courses in the Vocational discipline.</p> | <p>To secure the required minimum credits in each discipline, students who wish to opt for a Double Major should include the credits earned by them from the Multi-Disciplinary Courses, Skill Enhancement Courses, and Value-Added Courses offered by the respective Major disciplines.</p> <p>The Double Major pathway is extended to the fourth year. Shifting to a double major from a minor in the third semester will be allowed subject to clearance of the courses of double major (not studied earlier) in succeeding sessions.</p> <p>In the fourth year, the student can continue to earn the required credits in either Major A or Major B to qualify for a UG Degree (Honours)/ UG Degree (Honours with Research) in A or B.</p> <p>If he/she opts to continue with Major B in the fourth year, he/she should earn an additional 16 credits of 300-399 level in Major B through mandatory online courses. The institution will not provide the courses in physical mode in the fourth year of this segment.</p> |

**Table 3: Credit Distribution in Elective Courses during the Four Years of FYUGP**

| Academic Level | Level of Courses   | Semester  | Path A<br>ELC; Elective courses from<br>Interdisciplinary Subjects 1 & 2<br>(24) |               | Path B<br>ELC; Elective courses from the<br>discipline (24) | Path C<br>ELC; Elective courses from<br>vocational (24) | Path D<br>ELC; Elective courses from the<br>discipline for Double Major<br>(64) |
|----------------|--|---|--|---------------|---|---|---|
|                | 1  | 2   | 3A. Subject 1  | 3B. Subject 2 | 4   | 5   | 6   |
| Level 4.5      | Level 100-199:<br>Foundation or<br>Introductory courses                                      | I   | ---  | ---           | ---   | ---   | 4+4   |
|                |  | II  | ---  | ---           | ---   | ---   | 4+4   |
|                |  | Exit Point: Bachelor's Degree with Hons. with Research  |  |               |   |   |   |
| Level 5        | Level 200-299:<br>Intermediate-level courses   | III   | 4  | ---           | 4   | 4   | 4+4   |
|                |  | IV  | ---  | 4             | 4   | 4   | 4+4   |
|                |  | Exit Point: Bachelor's Degree with Hons.  |  |               |   |   |   |
| Level 5.5      | Level 300-399:<br>Higher-level courses   | V   | 4  | ---           | 4   | 4   | 4+4   |
|                |  | VI  | ---  | 4             | 4   | 4   | 4+4   |
|                |  | Exit Point: P.G. Diploma Degree   |  |               |   |   |   |
| Level 6        | Level 400-499:<br>Advanced courses<br>Hons with Research (>7.5 CGPA)/<br>Honours/ PG Diploma | VII   | 4  | ---           | 4   | 4   | 4+4   |
|                |  | VIII  | ---  | 4             | 4   | 4   | 4+4   |
|                |  | Exit Point: (A) Bachelor's Degree with Hons. with Research/ (B) Bachelor's Degree with Hons./ (C) P.G. Diploma Degree |  |               |   |   |   |

**COURSES OF STUDY FOR FOUR-YEAR UNDERGRADUATE PROGRAMME** 2025 onwards**Table 4: Semester-wise Course Code and Credit Points for Single Major during the First Three Years of FYUGP**

| Semester  | Common, Introductory, Major, Minor, Vocational & Internship Courses |  | Credits    |                                 |
|---|---|--|------------|---------------------------------|
|   | Code  | Papers   | Paper      | Semester                        |
| <b>I</b>  | AEC-1   | Language and Communication Skills (MIL-1; Modern Indian language Hindi/ English) | 2          | <b>7 Papers</b><br>(20 credits) |
|   | VAC-1   | Value Added Course-1   | 2          |                                 |
|   | IKS-1   | Indian Knowledge System-I (Foundation Course)                                    | 2          |                                 |
|   | SEC-1   | Skill Enhancement Course-1   | 3          |                                 |
|   | MDC-1   | Multi-disciplinary Course-1  | 3          |                                 |
|   | AC-1  | Associated core courses from discipline/ Interdisciplinary/ vocational           | 4          |                                 |
|   | MJ-1  | Major paper 1 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
| <b>II</b>   | AEC-2   | Language and Communication Skills (MIL-1; Modern Indian language English/ Hindi) | 2          | <b>7 Papers</b><br>(20 credits) |
|   | VAC-2   | Value Added Course-2   | 2          |                                 |
|   | SA  | Social Awareness Activities  | 2          |                                 |
|   | SEC-2   | Skill Enhancement Course-2   | 3          |                                 |
|   | MDC-2   | Multi-disciplinary Course-2  | 3          |                                 |
|   | AC-2  | Associated core courses from discipline/ Interdisciplinary/ vocational           | 4          |                                 |
|   | MJ-2  | Major paper 2 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
| <b>III</b>  | AEC-3   | Language and Communication Skills (MIL-2; MIL including TRL)                     | 2          | <b>6 Papers</b><br>(20 credits) |
|   | SEC-3   | Skill Enhancement Course-3   | 3          |                                 |
|   | MDC-3   | IKS as a Multi-disciplinary Course-3   | 3          |                                 |
|   | ELC-1   | Elective courses from discipline/ Interdisciplinary/ vocational                  | 4          |                                 |
|   | MJ-3  | Major paper 3 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
|   | MJ-4  | Major paper 4 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
| <b>IV</b>   | AEC-4   | Language and Communication Skills (MIL-2; MIL including TRL)                     | 2          | <b>6 Papers</b><br>(20 credits) |
|   | VAC-3   | Value Added Course-3   | 2          |                                 |
|   | ELC-2   | Elective courses from discipline/ Interdisciplinary/ vocational                  | 4          |                                 |
|   | MJ-5  | Major paper 5 (Disciplinary/ Interdisciplinary Major having IKS)                 | 4          |                                 |
|   | MJ-6  | Major paper 6 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
|   | MJ-7  | Major paper 7 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
| <b>V</b>  | ELC-3   | Elective courses from discipline/ Interdisciplinary/ vocational                  | 4          | <b>5 Papers</b><br>(20 credits) |
|   | MJ-8  | Major paper 8 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
|   | MJ-9  | Major paper 9 (Disciplinary/ Interdisciplinary Major)                            | 4          |                                 |
|   | MJ-10   | Major paper 10 (Disciplinary/ Interdisciplinary Major)                           | 4          |                                 |
|   | MJ-11   | Major paper 11 (Disciplinary/ Interdisciplinary Major)                           | 4          |                                 |
| <b>VI</b>   | ELC-4   | Elective courses from discipline/ Interdisciplinary/ vocational                  | 4          | <b>5 Papers</b><br>(20 credits) |
|   | MJ-12   | Major paper 12 (Disciplinary/ Interdisciplinary Major)                           | 4          |                                 |
|   | MJ-13   | Major paper 13 (Disciplinary/ Interdisciplinary Major)                           | 4          |                                 |
|   | MJ-14   | Major paper 14 (Disciplinary/ Interdisciplinary Major)                           | 4          |                                 |
|   | MJ-15   | Major paper 15 (Disciplinary/ Interdisciplinary Major)                           | 4          |                                 |
| <b>Total Credits, excluding one Internship (IAP) of 4 credits =</b> |   |  | <b>120</b> | <b>120</b>                      |

**Note:** It is mandatory to take One Internship of 4 credits in any one of the semesters during the first three years in FYUGP or before exit at any of the exit points if a student wishes to opt for the same.

**Table 5A: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (Honours with Research)**

| Semester   | Common, Introductory, Major, Minor, Vocational & Internship Courses |  | Credits |                          |
|--|---|--|---------|--------------------------|
|  | Code  | Papers   | Paper   | Semester                 |
| VII A  | ELC-5   | Elective courses from discipline/ Interdisciplinary/ vocational                  | 4       | 5 Papers<br>(20 credits) |
|  | MJ-16   | Major paper 16 (Research Methodology)  | 4       |                          |
|  | MJ-17   | Major paper 17 (Disciplinary/Interdisciplinary Major)                            | 4       |                          |
|  | MJ-18   | Major paper 18 (Disciplinary/Interdisciplinary Major)                            | 4       |                          |
|  | RC-1  | Research proposal – Planning & Techniques (Disciplinary/Interdisciplinary Major) | 4       |                          |
| VIII A   | ELC-6   | Elective courses from discipline/ Interdisciplinary/ vocational                  | 4       | 4 Papers<br>(20 credits) |
|  | MJ-19   | Major paper 19 (Disciplinary/Interdisciplinary Major)                            | 4       |                          |
|  | MJ-20   | Major paper 20 (Disciplinary/Interdisciplinary Major)                            | 4       |                          |
|  | RC-2  | Research Internship/Field Work/Project/Dissertation/Thesis                       | 8       |                          |
| Total Credits, excluding one Internship of 4 credits = |   |  | 160     | 160                      |

**Table 5B: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (Honours)**

| Semester   | Common, Introductory, Major, Minor, Vocational & Internship Courses |   | Credits |                          |
|--|---|---|---------|--------------------------|
|  | Code  | Papers  | Paper   | Semester                 |
| VII B  | ELC-5   | Elective courses from discipline/ Interdisciplinary/ vocational | 4       | 5 Papers<br>(20 credits) |
|  | MJ-16   | Major paper 16 (Disciplinary/Interdisciplinary Major)           | 4       |                          |
|  | MJ-17   | Major paper 17 (Disciplinary/Interdisciplinary Major)           | 4       |                          |
|  | MJ-18   | Major paper 18 (Disciplinary/Interdisciplinary Major)           | 4       |                          |
|  | AMJ-1   | Advanced Major paper-1 (Disciplinary/Interdisciplinary Major)   | 4       |                          |
| VIII B   | ELC-6   | Elective courses from discipline/ Interdisciplinary/ vocational | 4       | 5 Papers<br>(20 credits) |
|  | MJ-19   | Major paper 19 (Disciplinary/Interdisciplinary Major)           | 4       |                          |
|  | MJ-20   | Major paper 20 (Disciplinary/Interdisciplinary Major)           | 4       |                          |
|  | AMJ-2   | Advanced Major paper-2 (Disciplinary/Interdisciplinary Major)   | 4       |                          |
|  | AMJ-3   | Advanced Major paper-3 (Disciplinary/Interdisciplinary Major)   | 4       |                          |
| Total Credits, excluding one Internship of 4 credits = |   |   | 160     | 160                      |

**Table 5C: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (with Postgraduate Diploma)**

| Semester   | Common, Introductory, Major, Minor, Vocational & Internship Courses |   | Credits |                          |
|--|---|---|---------|--------------------------|
|  | Code  | Papers  | Paper   | Semester                 |
| VII C  | ELC-5   | Elective courses from discipline/ Interdisciplinary/ vocational       | 4       | 5 Papers<br>(20 credits) |
|  | MJ-16   | Major paper 16 (Disciplinary/Interdisciplinary Major)                 | 4       |                          |
|  | MJ-17   | Major paper 17 (Disciplinary/Interdisciplinary Major)                 | 4       |                          |
|  | MJ-18   | Major paper 18 (Disciplinary/Interdisciplinary Major)                 | 4       |                          |
|  | JOC-1   | Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major) | 4       |                          |
| VIII C   | ELC-6   | Elective courses from discipline/ Interdisciplinary/ vocational       | 4       | 5 Papers<br>(20 credits) |
|  | MJ-19   | Major paper 19 (Disciplinary/Interdisciplinary Major)                 | 4       |                          |
|  | MJ-20   | Major paper 20 (Disciplinary/Interdisciplinary Major)                 | 4       |                          |
|  | JOC-2   | Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major) | 4       |                          |
|  | JOC-3   | Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major) | 4       |                          |
| Total Credits, excluding one Internship of 4 credits = |   |   | 160     | 160                      |

**AIMS OF BACHELOR'S DEGREE PROGRAMME IN STATISTICS****The broad aims of the bachelor's degree programme in Statistics are:**

The broad aims of bachelor's degree programme in Statistics are as follows:

- (i) Traditionally, Statistics has been defined as a body of scientific methods used for collection, classification, presentation, analysis and interpretation of numerical data originating from diverse fields.
- (ii) The success of the subject therefore lies in its application. Perhaps there is no branch of scientific knowledge where Statistics has not left its imprint.
- (iii) To imbibe strong foundation of statistics in students.
- (iv) To familiarize students with basic to high-level statistical concepts.
- (v) To update students with mathematical tools that aid in statistical theory.
- (vi) To teach/strengthen students' knowledge of spreadsheets, programming languages and statistical packages.
- (vii) To promote application-oriented pedagogy by exposing students to real world data.
- (viii) To make students do projects, which prepares them for jobs/markets.

**PROGRAM LEARNING OUTCOMES**

**The broad learning outcomes of bachelor's degree programme in Statistics are:**

- i. This course exposes the students to the beautiful world of Statistics and how it affects each and every aspect of our daily life.
- ii. The course is designed to equip students with all the major concepts of Statistics along with the tools required to implement them.
- iii. Introduction to computer softwares help them in analysis of data by making optimum usage of time and resources.
- iv. These softwares give them the necessary support and an edge when progressing to their professional careers.
- v. Exposure to plethora of real-life data helps in honing their analytical skills.
- vi. Having practical component with every paper invokes their exploratory side and fine-tunes the interpretation abilities.
- vii. Such a pedagogy goes a long way in giving them the required impetus and confidence for consultancy startups/jobs in near future.
- viii. The structure of the course also motivates/helps the students to pursue careers in related disciplines, especially the data sciences, financial statistics and actuarial sciences.



**SEMESTER WISE COURSES IN STATISTICS HONOURS****2025 onwards****Table 6: Semester-wise Course Code and Credit Points of Major Courses in Statistics**

| Semester    | Courses |  | Examination Structure |                            |                            |                                     |
|-------------|---------|--|-----------------------|----------------------------|----------------------------|-------------------------------------|
|             | Code    | Courses in NEP FYUGP Syllabus of Statistics<br>Session 2025-26 & onwards | Credits               | Mid Semester Theory (F.M.) | End Semester Theory (F.M.) | End Semester Practical/ Viva (F.M.) |
| <b>I</b>    | MJ-1    | Descriptive Statistics and Index Numbers                                 | 4                     | 25                         | 75                         | ---                                 |
|             | SEC-1   | Numerical Analysis   | 3                     | ---                        | 75                         | ---                                 |
| <b>II</b>   | MJ-2    | Probability Theory   | 4                     | 25                         | 75                         | ---                                 |
|             | SEC-2   | Theory of Sets, Numbers and Equations                                    | 3                     | ---                        | 75                         | ---                                 |
| <b>III</b>  | MJ-3    | Sampling Distributions   | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-4    | Practical-I  | 4                     | ---                        | ---                        | 100                                 |
|             | SEC-3   | Elementary Computer Application Softwares                                | 3                     | ---                        | 75                         | ---                                 |
| <b>IV</b>   | MJ-5    | IKS in Statistics  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-6    | Survey Sampling  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-7    | Practical-II   | 4                     | ---                        | ---                        | 100                                 |
| <b>V</b>    | MJ-8    | Statistical Inference  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-9    | Real Analysis  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-10   | Linear Models  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-11   | Practical-III  | 4                     | ---                        | ---                        | 100                                 |
| <b>VI</b>   | MJ-12   | Operations Research  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-13   | Demography & Vital Statistics  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-14   | Linear Algebra   | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-15   | Practical-IV   | 4                     | ---                        | ---                        | 100                                 |
| <b>VII</b>  | MJ-16   | Research Methodology   | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-17   | Multivariate Statistical Analysis  | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-18   | Practical-V  | 4                     | ---                        | ---                        | 100                                 |
|             | AMJ-1/  | Bayesian Inference OR  | 4                     | 25                         | 75                         | ---                                 |
|             | RC-1    | Research Planning & Techniques   | 4                     | 25                         | 75                         | ---                                 |
| <b>VIII</b> | MJ-19   | Design & Analysis of Experiments   | 4                     | 25                         | 75                         | ---                                 |
|             | MJ-20   | Practical-VI   | 4                     | ---                        | ---                        | 100                                 |
|             | AMJ-2   | Stochastic Processes & Queuing Theory                                    | 4                     | 25                         | 75                         | ---                                 |
|             | AMJ-3/  | Practical-VII (Advanced Statistics)                                      | 4                     | ---                        | ---                        | 100                                 |
|             | RC-2    | Project Dissertation/ Research Internship/ Field Work                    | 8                     | 50                         | ---                        | 150                                 |

\* It is mandatory to take Either One Internship of 4 credits or Two Internships of 2 credits each in any one of the semesters during the first three years in FYUGP or before exit at any of the exit points if a student wishes to opt for the same.

**Table 7: Semester-wise Course Code and Credit Points of Minor Courses in Statistics**

| Courses |   | Examination Structure |                            |                            |                                     |
|---------|---|-----------------------|----------------------------|----------------------------|-------------------------------------|
| Code    | Minor Courses in NEP FYUGP Syllabus of Economics<br>Session 2025-26 & onwards | Credits               | Mid Semester Theory (F.M.) | End Semester Theory (F.M.) | End Semester Practical/ Viva (F.M.) |
| MN-A    | Introductory Statistics   | 4                     | 25                         | 75                         | ---                                 |
| MN-B    | Introductory Probability  | 4                     | 15                         | 60                         | 25                                  |
| MN-C    | Statistical Inference   | 4                     | 15                         | 60                         | 25                                  |
| MN-D    | Linear Models   | 4                     | 15                         | 60                         | 25                                  |
| MN-E    | Demography and Vital Statistics   | 4                     | 15                         | 60                         | 25                                  |
| MN-F    | Times Series Analysis   | 4                     | 15                         | 60                         | 25                                  |
| MN-G    | Statistical Quality Control   | 4                     | 15                         | 60                         | 25                                  |

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## INSTRUCTION TO QUESTION SETTER

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### SEMESTER INTERNAL EXAMINATION (SIE):

There will be Only One Semester Internal Examination in Major, Minor and Research Courses, which will be organized at college/institution level. However, Only One End semester evaluation in other courses will be done either at College/ Institution or University level depending upon the nature of course in the curriculum.

#### **A. (SIE 10+5=15 marks):**

There will be two group of questions. **Question No.1 will be very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks.

#### **B. (SIE 20+5=25 marks):**

There will be two group of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

**Conversion of Attendance into score may be as follows:**

Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks.

### END SEMESTER UNIVERSITY EXAMINATION (ESE):

#### **A. (ESE 50 marks):**

There will be two group of questions. **Group A is compulsory** which will contain one question. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

#### **B. (ESE 60 marks):**

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

#### **C. (ESE 75 marks):**

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to answer.

#### **D. (ESE 100 marks):**

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of twenty marks each, out of which any four are to answer.

**FORMAT OF QUESTION PAPER FOR MID/ END SEMESTER EXAMINATIONS****Question format for 15 Marks:**

| <b>F.M. =15</b>  | <b>Subject/ Code</b><br><b>Time = 1 Hr.</b>             | <b>Exam Year</b> |
|--|---|------------------|
| <b>General Instructions:</b>   |   |                  |
| i. <b>Group A</b> carries very short answer-type compulsory questions.<br>ii. <b>Answer 1 out of 2</b> subjective/ descriptive questions given in <b>Group B</b> .<br>iii. Answer in your own words as far as practicable.<br>iv. Answer all subparts of a question in one place.<br>v. Numbers in the right indicate full marks for the question. |   |                  |
| <b><u>Group A</u></b>  |   |                  |
| 1.   | i. ....<br>ii. ....<br>iii. ....<br>iv. ....<br>v. .... | [5x1=5]          |
| <b><u>Group B</u></b>  |   |                  |
| 2. ....  |   | [10]             |
| 3. ....  |   | [10]             |
| <b>Note:</b> There may be subdivisions in each question asked in Theory Examination.   |   |                  |

**Question format for 20 Marks:**

| <b>F.M. =20</b>  | <b>Subject/ Code</b><br><b>Time = 1 Hr.</b>             | <b>Exam Year</b> |
|--|---|------------------|
| <b>General Instructions:</b>   |   |                  |
| i. <b>Group A</b> carries very short answer-type compulsory questions.<br>ii. <b>Answer 1 out of 2</b> subjective/ descriptive questions given in <b>Group B</b> .<br>iii. Answer in your own words as far as practicable.<br>iv. Answer all subparts of a question in one place.<br>v. Numbers in the right indicate full marks for the question. |   |                  |
| <b><u>Group A</u></b>  |   |                  |
| 1.   | i. ....<br>ii. ....<br>iii. ....<br>iv. ....<br>v. .... | [5x1=5]          |
| 2. ....  |   | [5]              |
| <b><u>Group B</u></b>  |   |                  |
| 3. ....  |   | [10]             |
| 4. ....  |   | [10]             |
| <b>Note:</b> There may be subdivisions in each question asked in the Theory Examination.   |   |                  |

**Question format for 50 Marks:**

| Subject/ Code  |                 | Exam Year |
|--|-----------------|-----------|
| F.M. =50   | Time = 1.5 Hrs. |           |
| <b>General Instructions:</b>   |                 |           |
| i. <b>Group A</b> carries very short answer-type compulsory questions.<br>ii. <b>Answer 3 out of 5</b> subjective/ descriptive questions given in <b>Group B</b> .<br>iii. Answer in your own words as far as practicable.<br>iv. Answer all subparts of a question in one place.<br>v. Numbers in the right indicate full marks for the question. |                 |           |
| <b><u>Group A</u></b>  |                 |           |
| 1.   |                 | [5x1=5]   |
| i.   | .....           |           |
| ii.  | .....           |           |
| iii.   | .....           |           |
| iv.  | .....           |           |
| v.   | .....           |           |
| <b><u>Group B</u></b>  |                 |           |
| 2.   | .....           | [15]      |
| 3.   | .....           | [15]      |
| 4.   | .....           | [15]      |
| 5.   | .....           | [15]      |
| 6.   | .....           | [15]      |
| <b>Note:</b> There may be subdivisions in each question asked in the Theory Examination.   |                 |           |

**Question format for 60 Marks:**

| Subject/ Code  |               | Exam Year |
|--|---------------|-----------|
| F.M. =60   | Time = 3 Hrs. |           |
| <b>General Instructions:</b>   |               |           |
| i. <b>Group A</b> carries very short answer-type compulsory questions.<br>ii. <b>Answer 3 out of 5</b> subjective/ descriptive questions given in <b>Group B</b> .<br>iii. Answer in your own words as far as practicable.<br>iv. Answer all subparts of a question in one place.<br>v. Numbers in the right indicate full marks for the question. |               |           |
| <b><u>Group A</u></b>  |               |           |
| 1.   |               | [5x1=5]   |
| i.   | .....         |           |
| ii.  | .....         |           |
| iii.   | .....         |           |
| iv.  | .....         |           |
| v.   | .....         |           |
| 2.   | .....         | [5]       |
| 3.   | .....         | [5]       |
| <b><u>Group B</u></b>  |               |           |
| 4.   | .....         | [15]      |
| 5.   | .....         | [15]      |
| 6.   | .....         | [15]      |
| 7.   | .....         | [15]      |
| 8.   | .....         | [15]      |
| <b>Note:</b> There may be subdivisions in each question asked in the Theory Examination.   |               |           |

Question format for 75 Marks:

| Subject/ Code  |               | Exam Year |
|--|---------------|-----------|
| F.M. =75   | Time = 3 Hrs. |           |
| <b>General Instructions:</b>   |               |           |
| i. <b>Group A</b> carries very short answer-type compulsory questions.<br>ii. <b>Answer 4 out of 6</b> subjective/ descriptive questions given in <b>Group B</b> .<br>iii. Answer in your own words as far as practicable.<br>iv. Answer all subparts of a question in one place.<br>v. Numbers in the right indicate full marks for the question. |               |           |
| <b><u>Group A</u></b>  |               |           |
| 1.   |               | [5x1=5]   |
| i. ....  |               |           |
| ii. ....   |               |           |
| iii. ....  |               |           |
| iv. ....   |               |           |
| v. ....  |               |           |
| 2. ....  |               | [5]       |
| 3. ....  |               | [5]       |
| <b><u>Group B</u></b>  |               |           |
| 4. ....  |               | [15]      |
| 5. ....  |               | [15]      |
| 6. ....  |               | [15]      |
| 7. ....  |               | [15]      |
| 8. ....  |               | [15]      |
| 9. ....  |               | [15]      |
| <b>Note:</b> There may be subdivisions in each question asked in the Theory Examination.   |               |           |

Question format for 100 Marks:

| Subject/ Code  |               | Exam Year |
|--|---------------|-----------|
| F.M. =100  | Time = 3 Hrs. |           |
| <b>General Instructions:</b>   |               |           |
| i. <b>Group A</b> carries very short answer-type compulsory questions.<br>ii. <b>Answer 4 out of 6</b> subjective/ descriptive questions given in <b>Group B</b> .<br>iii. Answer in your own words as far as practicable.<br>iv. Answer all subparts of a question in one place.<br>v. Numbers in the right indicate full marks for the question. |               |           |
| <b><u>Group A</u></b>  |               |           |
| 1.   |               | [10x1=10] |
| i. ....  | vi. ....      |           |
| ii. ....   | vii. ....     |           |
| iii. ....  | viii. ....    |           |
| iv. ....   | ix. ....      |           |
| v. ....  | x. ....       |           |
| 2. ....  |               | [5]       |
| 3. ....  |               | [5]       |
| <b><u>Group B</u></b>  |               |           |
| 4. ....  |               | [20]      |
| 5. ....  |               | [20]      |
| 6. ....  |               | [20]      |
| 7. ....  |               | [20]      |
| 8. ....  |               | [20]      |
| 9. ....  |               | [20]      |
| <b>Note:</b> There may be subdivisions in each question asked in the Theory Examination.   |               |           |

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## SEMESTER I

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### I. MAJOR COURSE –MJ 1: DESCRIPTIVE STATISTICS AND INDEX NUMBERS

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

#### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Provide basic information about variables in a dataset and to highlight potential relationships between variables.
2. The concept of index numbers will enable students to provide a value useful for comparing magnitudes of aggregates of related variables to each other, and to measure the changes in these magnitudes over time.
3. The concept of index numbers will enable students to provide a value useful for comparing magnitudes of aggregates of related variables to each other, and to measure the changes in these magnitudes over time.
4. Various methods of graphical representation of statistical data.
5. Construct of various index numbers including consumer price index.

#### Course Content:

**UNIT 1:** Definition, Importance, scope and limitations of Statistics, concepts of statistical population and sample. Scales of measurement- nominal, ordinal, interval and ratio. Theory of attributes, consistency of data, independence and association of attributes, measures of association.

**UNIT 2:** Data: quantitative and qualitative, attributes, variables. Primary and Secondary data, Methods of collection of Primary and Secondary data. Presentation of data: tabular and graphical, including histogram and ogives.

**UNIT 3:** Measures of Central Tendency: mathematical and positional, their relative merits and demerits Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.

**UNIT 4:** Bivariate data: Definition, scatter diagram, Karl Pearson product moment correlation coefficient and its properties, rank correlation, partial and multiple correlation (3 variables only). Simple linear regression, properties of regression coefficients, principle of least squares and fitting of polynomials & exponential curves.

**UNIT 5:** Index Numbers: Definition, construction of index numbers and problems there of for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's. Time reversal and factor reversal tests, Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

#### Reference Books:

1. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
  2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
  3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
  4. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
  5. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
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## II. SKILL ENHANCEMENT COURSE- SEC 1: NUMERICAL ANALYSIS

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: 75 (ESE: 3Hrs) = 75</b> | <b>Pass Marks: Th (ESE) = 30</b> |
|-----------------------------------|----------------------------------|

(Credits: Theory-03) **45 Hours****Course Objectives & Learning Outcomes:**

This course will enable the students to:

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2. Apply numerical methods to obtain approximate solutions to mathematical problems.
3. Derive numerical methods for various mathematical operations and tasks, such as interpolation, integration.
4. Analyse and evaluate the accuracy of common numerical methods.

**Course Content:**

**UNIT 1:** Error in approximations: Approximate numbers and significant figures, Error and their computation, Propagation of Errors, General Formula of Errors.

**UNIT 2:** Solution of algebraic and transcendental equations: Bisection method, Regula-Falsi method, Iterative Method, Newton-Raphson method. Solution of simultaneous equations: Gauss's elimination method, Matrix Inversion by Triangularization method.

**UNIT 3:** Calculus of finite difference: The operators  $\Delta$ ,  $\nabla$ ,  $E$ , factorial notation, their properties and interrelation between them, Fundamental theorem of difference calculus, divided differences

**UNIT 4:** Interpolation-Newton's forward and backward difference interpolation formula, Lagrange's interpolation formula. Central difference interpolation, Gauss's forward, backward and central difference formula.

**Note:** Use of Scientific Calculator will be Allowed in End Semester Examination.

**Reference Books:**

1. Numerical Analysis – J B Scarborough.
  2. Numerical Analysis – B S Grewal.
  3. Numerical Analysis – G S Mallik.
  4. Numerical Methods-E Balagurusamy
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## SEMESTER II

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### I. MAJOR COURSE- MJ 2: PROBABILITY THEORY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) 60 Hours

#### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Learn the concept of various approaches of probability.
2. Calculate probabilities using probability laws and theoretical results.
3. Understand the concept of random variable and probability distributions.
4. Identify an appropriate probability distribution for a given random variable and use its properties to calculate probabilities.
5. Experience the real life application of the underlying probability distributions.
6. Fit appropriate probability distribution to the data.

#### Course Content:

**UNIT 1:** Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic., laws of addition and multiplication, independence and mutual independence of events, Theorem of total probability, conditional probability, Bayes' theorem and its applications.

**UNIT 2:** Random variables: discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations with illustrations.

**UNIT 3:** Mathematical Expectation: Expectation of univariate and bivariate random variables and its properties. Conditional expectations.

**UNIT 4:** Moments and Cumulants, moment generating function, cumulant generating function, characteristic function and probability generating functions and their properties. Uniqueness and inversion theorems (without proof) along with applications.

**UNIT 5:** Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases.

#### Reference Books:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
  2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
  3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
  4. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
  5. An Introduction to the Probability and Statistics, V. K. Rohatgi and E. Saleh.
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## II. SKILL ENHANCEMENT COURSE- SEC 2: THEORY OF SETS, NUMBERS AND EQUATIONS

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: 75 (ESE: 3Hrs) = 75</b> | <b>Pass Marks: Th (ESE) = 30</b> |
|-----------------------------------|----------------------------------|

(Credits: Theory-03) **45 Hours****Course Objectives & Learning Outcome:**

This course will enable the students to:

1. Familiarize the basics of set, equivalence class and countability of sets which are essential part of the development of other important mathematical structures.
2. Learn basic number theory which is helpful in notion of higher algebra.
3. Generalize the idea of quadratic equations into higher degree polynomial equations.

**Course Content****UNIT-1: Set Theory**

Relations, Equivalence relations, Equivalence classes, Functions, Composition of functions, Inverse of a function, Finite and infinite sets, Countable and uncountable sets, Cardinality of sets, cardinal numbers.

**UNIT-2: Number Theory**

The division algorithm, Divisibility and Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences, Principles of mathematical induction and well ordering, Diophantine equations.

**UNIT-3: Theory of Equations**

Elementary theorems on the roots of an equations including Cardan's method, The remainder and factor theorems, Synthetic division, Factored form of a polynomial.

**UNIT-4:**

The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots, Integral and rational roots; The nth roots of unity, De Moivre's theorem for integer and rational indices and its applications.

## Reference Books:

1. M. K. Gupta (2008). Discrete Mathematics. Krishna Prakashan.
  2. S. B. Malik (2008). Basic Number Theory. Vikas Publishing House.
  3. Lalji Prasad (2016). Theory of Equations. Paramount Publications.
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## SEMESTER III

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### I. MAJOR COURSE- MJ 3: SAMPLING DISTRIBUTIONS

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

#### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Determine the probability of an event based on data from a small group within a large population.
2. Establish representative results of small samples of a comparatively larger population.
3. Apply the central limit theorem to calculate approximate probabilities for sample means and sample proportions.
4. Experience the real life application of the underlying distribution of the population, the statistic being considered, the sampling procedure employed and the sample size used.
5. Analytical considerations to be based on sampling distribution of a statistic rather than on the joint probability distribution of all the individual sample values.

#### Course Content:

**UNIT 1:** Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations. Chebyshev's inequality, W.L.L.N., and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof).

**UNIT 2:** Order Statistics: Introduction, distribution of the  $r$ th order statistic, smallest and largest order statistics. Joint distribution of  $r$ th and  $s$ th order statistics, distribution of sample median and sample range.

**UNIT 3:** Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.

**UNIT 4:** Exact sampling distribution: Definition and derivation of p.d.f. of  $\chi^2$  using m.g.f., mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of  $\chi^2$  distribution. Tests of significance and confidence intervals based on  $\chi^2$  distribution.

**UNIT 5:** Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its p.d.f., mean, variance, moments and limiting form of t distribution. Snedecore's F-distribution: Derivation of p.d.f., mean, variance and mode. Distribution of  $1/F(n_1, n_2)$ . Relationship between t, F and  $\chi^2$  distributions. Test of significance and confidence Intervals based on t and F distributions.

#### Reference Books:

1. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4<sup>th</sup> Edn. World Press, Kolkata.
  2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
  3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
  4. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4<sup>th</sup> Edn. John Wiley and Sons.
  5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3<sup>rd</sup> Edn. (Reprint).
  6. Tata McGraw-Hill Pub. Co. Ltd.
  7. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
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## II. MAJOR COURSE- MJ 4: PRACTICALS-I

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) =100</b> | <b>Pass Marks: Pr (ESE) = 40</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-04) 120 Hours

***Instruction to Question Setter for  
End Semester Examination (ESE):***

*There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:*

*Experiment = 60 marks*

*Practical record notebook = 15 marks*

*Viva-voce = 25 marks*

**Practicals:**

**Course Contents:**

**UNIT 1:** Graphical representation of data

**UNIT 2:** Problems based on measures of central tendency, measures of dispersion, measures of location. Problems based on theory of attributes

**UNIT 3:** Problems based on correlation and regression. Problems based on Index Numbers.

**UNIT 4:** Problems based on fitting of suitable probability distribution to the given data.

**UNIT 5:** Problems based on large sample theory. Problems based on exact sampling distributions i.e., t tests, Chi square tests and F tests.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4<sup>th</sup> Edn. World Press, Kolkata.
  2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
  3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
  4. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4<sup>th</sup> Edn. John Wiley and Sons.
  5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3<sup>rd</sup> Edn. (Reprint). Tata McGraw-Hill Pub. Co. Ltd.
  6. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
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### III. SKILL ENHANCEMENT COURSE- SEC 3: ELEMENTARY COMPUTER APPLICATION SOFTWARES

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: 75 (ESE: 3Hrs) = 75</b> | <b>Pass Marks: Th (ESE) = 30</b> |
|-----------------------------------|----------------------------------|

#### A Common Syllabus for FYUGP

(Credits: Theory-03) 45 Hours

##### Instruction to Question Setter

There will be **objective type test** consisting of **Seventy-five questions of 1 mark each**. Students are required to mark their answer on **OMR Sheet** provided by the University.

##### Course Objectives:

The objective of the course is to generate qualified manpower in the area of Information Technology (IT) and Graphic designing which will enable such person to work seamlessly at any Offices.

- 1. Basic Concept of Computer:** What is a Computer, Applications of Computer, Types of Computer, Components of a Computer System, Central Processing Unit (CPU) **(3 Hours)**
- 2. Concepts of Hardware:** Input Devices, Output Devices, Computer Memory, Types of Memory, Processing Concept of Computer **(4 Hours)**
- 3. Operating system:** Operating System, Functions of Operating System (Basic), Introduction to Windows 11, Working on Windows 11 environment, Installation of Application Software, My Computer, Control Panel, searching techniques in Windows environment, Basic of setting **(6 Hours)**
- 4. Concept of Software:** What is Software, Types of Software, Computer Software- Relationship between Hardware and Software, System Software, Application Software, some high-level languages **(4 Hours)**
- 5. Internet & its uses:** Basic of Computer networks; LAN, WAN, MAN, Concept of Internet, Applications of Internet; connecting to internet, what is ISP, World Wide Web, Web Browsing software's, Search Engines, URL, Domain name, IP Address, using e-governance website, Basics of electronic mail, getting an email account, Sending and receiving emails. **(6 Hours)**
- 6. Microsoft Word:** Word processing concepts, Creation of Documents, Formatting of Documents, Formatting of Text, Different tabs of Word 2016 environment, Formatting Page, Navigation of Page, Table handling, Header and footer, Page Numbering, Page Setup, Find and Replace, Printing the documents **(7 Hours)**
- 7. Microsoft Excel (Spreadsheet):** Spreadsheet Concepts, Creating, Saving and Editing a Workbook, Inserting, Deleting Worksheets, Formatting worksheet, Excel Formula, Concept of charts and Applications, Pivot table, Goal Seek, Data filter, data sorting and scenario manager, printing the spreadsheet **(6 Hours)**
- 8. Microsoft PowerPoint (Presentation Package):** Concept and Uses of presentation package, Creating, Opening and Saving Presentations, working in different views in PowerPoint, Animation, slide show, Master Slides, Creating photo album, Rehearse timing and record narration **(5 Hours)**
- 9. Digital Education:** Introduction & Advantages of Digital Education, Concept of e-learning, Technologies used in e learning **(4 Hours)**

##### Reference Books

1. Nishit Mathur, *Fundamentals of Computer*, APH publishing corporation (2010)
2. Neeraj Singh, *Computer Fundamentals (Basic Computer)*, T Balaji, (2021)
3. Joan Preppernau, *Microsoft Power Point 2016 step by step*, Microsoft press (2015)
4. Douglas E Corner, *The Internet Book 4<sup>th</sup> Edition*, prentice –Hall (2009)
5. Wallace Wang, *Microsoft Office 2019*, Wiley (January 2018)
6. Noble Powell, *Windows 11 User Guide For Beginners and Seniors*, ASIN, (October 2021)

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## SEMESTER IV

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### I. MAJOR COURSE- MJ 5: IKS IN STATISTICS

|   |  |
|---|--|
| <b>Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100</b> | <b>Pass Marks: Th (SIE + ESE) = 40</b> |
|---|--|

(Credits: Theory-04) **60 Hours****Course Objectives & Learning Outcomes:**

1. To introduce students to the evolution of statistical thinking within the Indian Knowledge System(IKS).
2. To understand the role of statistics in ancient Indian texts, astronomy, architecture, medicine, economics and governance.
3. To explore indigenous methods of data collection, inference, and measurement.
4. To connect traditional statistical wisdom with modern statistical theories and applications.

**Course Content:**

**UNIT 1:** Introduction to Indian Knowledge System: philosophy, domains, and interdisciplinary nature. Early evidence of statistical thought in Indian civilization (Indus Valley inscriptions, trade records, population counts).

**UNIT 2:** Concept of Ankana (enumeration), Parimana (measurement), Ganita (computation) in Vedic and classical texts. Role of mathematics and Statistics in Sulbasutras and Vedang Jyotisha.

**UNIT 3:** Statistics in ancient Indian texts: enumeration and combinatorics in Pingala's Chandas Shastra (prosody and binary system). Use of probability concepts in games of dice (Aksha Shastra, Mahabharata references).

**UNIT 4:** Statistical thinking in Kautilya's Arthashastra – census, revenue, estimation, population surveys, and economic planning

**UNIT 5:** Quantification and inference in Ayurveda (Charaka Samhita and Sushruta Samhita): clinical observations, data based diagnosis.

**Reference Books:**

1. K.V.Sarma, A History of the Kerala School of Hindu Astronomy.
  2. S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks.
  3. Debiprasad Chattopadhyaya, History of Science and Technology in Ancient India.
  4. Michel Danino, Indian Knowledge Systems.
  5. Original passages from Arthashastra, Pingala's Chandas Shastra, Charaka Samhita, and Sulbasutras.
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## II. MAJOR COURSE- MJ 6: SURVEY SAMPLING

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Draw valid conclusions about the larger group.
2. Check the characteristics of population in less time through less effort and least cost.
3. Determine the accuracy of research/survey result.
4. Select members from a target population to be in a sample for a sample survey.

### Course Content:

**UNIT 1:** Concept of population and sample, complete enumeration versus sampling, sampling and non sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey.

**UNIT 2:** Simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

**UNIT 3:** Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision, post stratification and its performance. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ( $N=nk$ ). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

**UNIT 4:** Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS.

**UNIT 5:** Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters). Relative efficiency of cluster sampling with SRS in terms of intra class correlation.

### Reference Books:

1. Cochran W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
  2. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey with Application, IOWA State University Press and Indian Society of Agricultural Statistics
  3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
  4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
  5. Gun A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press.
  6. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.
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### III. MAJOR COURSE- MJ 7: PRACTICALS-II

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) =100</b> | <b>Pass Marks: Pr (ESE) = 40</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-04) 120 Hours

**Instruction to Question Setter for****End Semester Examination (ESE):**

There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks

Practical record notebook = 15 marks

Viva-voce = 25 marks

**Practicals:**

1. To select a SRS with and without replacement.
2. Estimation of population mean, Variance, population mean square error in case of with and without replacement for a given sample size.
3. Stratified sampling: allocation of sample to strata by proportional and Neyman's methods and to compare their efficiencies.
4. Estimation of gain in precision in stratified sampling.
5. Ratio and regression estimation: Calculate the population mean or total of the population. Calculate mean squares: Compare the efficiencies of ratio and regression estimators relative to SRS.
6. Cluster sampling: estimation of mean or total, variance of the estimate, estimate of intra- class correlation coefficient, efficiency as compared to SRS.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Gun A.M., Gupta M.K.: Das Gupta.B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
  2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2<sup>nd</sup> Edn. (Reprint) John Wiley and Sons.
  2. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6<sup>th</sup> addition, low price edition), Prentice Hall of India.
  3. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
  4. Mood A.M, Graybill F.A. and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill.
  5. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
  6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4<sup>th</sup> Edition. Marcel Dekker, CRC.
  7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.
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## SEMESTER V

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### I. MAJOR COURSE- MJ 8: STATISTICAL INFERENCE

|   |  |
|---|--|
| <b>Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100</b> | <b>Pass Marks: Th (SIE + ESE) = 40</b> |
|---|--|

(Credits: Theory-04) **60 Hours****Course Objectives & Learning Outcomes:**

This course will enable the students to:

1. Estimate the sample to sample variation or uncertainty.
2. Provide estimates of unknown parameters from sample statistics.
3. Make an inference about the population of interest on the basis of a random sample taken from that population.
4. Hypothesize various advanced statistical techniques for modeling and exploring practical situations.

**Course Content:****UNIT 1:** Estimation: Problem of estimation, Properties of a good estimator - unbiasedness, consistency, efficiency and sufficiency.**UNIT 2:** Factorization theorem. Cramer-Rao inequality and MVB estimators (statement and applications), Minimum variance unbiased estimator (MVUE), Rao-Blackwell theorem, Complete statistic, Lehmann-Scheffe theorems and their applications.**UNIT 3:** Methods of Estimation: Method of moments, method of maximum likelihood, method of minimum Chi-square, basic idea of Bayes estimators. Properties of maximum likelihood estimators (without proof).**UNIT 4:** Testing of hypothesis: Null and alternative hypotheses, simple and composite hypotheses, Type-I and Type-II errors, critical region, level of significance, size and power of a test, best critical region.**UNIT 5:** Most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).**Reference Books:**

1. Gun A.M., Gupta M.K.: Das Gupta. B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
  2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2<sup>nd</sup> Edn. (Reprint) John Wiley and Sons.
  3. Miller, I. and Miller, M. (2002): John E. Freund's Mathematical Statistics (6<sup>th</sup> addition, low price edition), Prentice Hall of India.
  4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
  5. Mood A.M, Graybill F.A. and Boes D.C.: Introduction to the Theory of Statistics, McGraw Hill.
  6. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
  7. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4<sup>th</sup> Edition. Marcel Dekker, CRC.
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## II. MAJOR COURSE- MJ 9: REAL ANALYSIS

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Describe the fundamental properties of the real numbers that underpin the formal development of real analysis;
2. Demonstrate an understanding of the theory of sequences and series, continuity, differentiation and integration;
3. Demonstrate skills in constructing rigorous mathematical arguments;
4. Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty;
5. Demonstrate skills in communicating mathematics.

### Course Content:

**UNIT 1:** Sequences and their convergence: Sequences, bounded sequence, convergent sequence, monotonic sequence, subsequence, Cauchy's general principle of convergence.

**UNIT 2:** Infinite Series: Convergence and divergence of infinite series of real numbers, Pringsheim's theorem, Comparison test, Cauchy's root test, D'Alembert's ratio test, Raabe's test, De-Morgan's and Bertrand's test, Gauss's ratio test, Cauchy's condensation test.

**UNIT 3:** Alternating Series, Leibnitz test, Absolute and conditional convergence. Taylor's theorem, Maclaurin's theorem, remainder after n terms. Power series expansions of:  $\sin$ ,  $\cos$ ,  $x \times e^x$ ,  $(1+x)^n$ ,  $\log(1+x)$  using suitable remainder after n terms.

**UNIT 4:** Limit, continuity and differentiability, relationship with continuity, Rolle's theorem, Lagrange's and Cauchy's mean value theorems,

**UNIT 5:** Uniform continuity. Curve tracing, evaluation of double integral, change of order of Integration, transformation of variables.

### Reference Books:

1. Introduction to Real Analysis – R Bartle & D R Sherbert.
  2. Elements of Real Analysis – Shanti Narayan & M D Raisinghania.
  3. The Theory of Calculus – K. A. Ross (2013).
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### III. MAJOR COURSE- MJ 10: LINEAR MODELS

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

#### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Develop a deeper understanding of the linear regression model.
2. Define the explanatory variable as the independent variable (predictor), and the response variable as the dependent variable (predicted).
3. When describing the association between two numerical variables, evaluate
  - a. direction: positive ( $x \uparrow, y \uparrow$ ), negative ( $x \downarrow, y \uparrow$ )
  - b. form: linear or not
  - c. strength: determined by the scatter around the underlying relationship.
4. Define correlation as the linear association between two numerical variables.
5. Define the least squares line as the line that minimizes the sum of the squared residuals, and list conditions necessary for fitting such line: (1) linearity, (2) nearly normal residuals, (3) constant variability.
6. Plot the explanatory variable ( $x$ ) on the x-axis and the response variable ( $y$ ) on the y-axis, and fit a linear regression model

$$y = \beta_0 + \beta_1 x$$

where,  $\beta_0$  is the intercept and  $\beta_1$  is the slope.

Note that the point estimates (estimated from observed data) for  $\beta_0$  and  $\beta_1$  are  $b_0$  and  $b_1$ , respectively.

#### Course Content:

**UNIT 1:** Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

**UNIT 2:** Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.

**UNIT 3:** Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models,

**UNIT 4:** Analysis of variance and covariance in two way classified data with one observation per cell for fixed effect models.

**UNIT 5:** Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.

#### Reference Books:

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.
4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
5. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4<sup>th</sup> Edition, McGraw Hill Companies.
6. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
7. Koutsoyiannis, A. (2004): Theory of Econometrics, 2<sup>nd</sup> Edition, Palgrave Macmillan Limited.
8. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4<sup>th</sup> Edition, John Wiley & Sons.

**IV. MAJOR COURSE- MJ 11:  
PRACTICALS-III****Marks: Pr (ESE: 6Hrs) =100****Pass Marks: Pr (ESE) = 40**(Credits: Practicals-04) **120 Hours*****Instruction to Question Setter for******End Semester Examination (ESE):****There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:**Experiment = 60 marks**Practical record notebook = 15 marks**Viva-voce = 25 marks***Practicals:**

1. ANOCOVA in one way classified data for fixed effect model
2. Problems based on simple regression model and multiple regression model.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6<sup>th</sup> Edition, Wiley India Pvt. Ltd.
  2. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8<sup>th</sup> Edn. The World Press, Kolkata.
  3. Mitra, A.: Statistical Quality Control and Improvement, Wiley India Pvt. Ltd.
  4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.
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## SEMESTER VI

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### I. MAJOR COURSE- MJ 12: OPERATIONS RESEARCH

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

#### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. The fundamental concepts of Operational Research Techniques.
2. Concepts of Linear Programming.
3. Concepts of Assignment Problem.

#### Course Content:

**UNIT 1:** Convex sets and their properties, Introduction to linear programming problem, solution by graphical method. Simplex method, optimality and unboundedness, artificial variables, two phase method, Big M method. Duality, formulation of the dual problem, primal dual relationships, economic interpretation of the dual.

**UNIT 2:** Transportation problem and its mathematical formulation, north-west corner method, least cost method and Vogel approximation method for determination of initial basic solution, algorithm for solving transportation problem. Transportation problem as a linear programming problem.

**UNIT 3:** Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Assignment problem as a linear programming problem.

**UNIT 4:** Rules of network construction, Time calculation in networks, Critical path method, PERT, calculation, advantages of network (PERT/CPM).

**UNIT 5:** Game Theory: Formulation and solution of two- person zerosum games, Games with mixed strategies, Linear programming method for solving a game.

#### Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2<sup>nd</sup> Ed., John Wiley and Sons, India, 2004.
  2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9<sup>th</sup> Ed., Tata McGraw Hill, Singapore, 2009.
  3. Hamdy A. Taha, Operations Research, An Introduction, 8<sup>th</sup> Ed., Prentice-Hall India, 2006.
  4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
  5. Operations Research – S D Sharma.
  6. Linear Programming Problems – R K Gupta.
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## II. MAJOR COURSE- MJ 13: DEMOGRAPHY & VITAL STATISTICS

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

### Course Objectives & Learning Outcomes:

1. Distinction between Vital Statistics and Demography.
2. To check the completeness of registration data using Chandrasekharan –Deming formula.
3. Use Myers' and UN indices in evaluating age data.
4. Use of Balancing Equations.
5. Population Composition and Dependency Ratio.
6. Basic measures of Mortality, Fertility, Life tables, their construction and uses, and Concept of Abridged life and their construction by Reed and Merrell method and Concept of Stable and Stationary Populations.
7. Basic measures of Fertility and Measures of Population Growth.

### Course Content:

**UNIT 1:** Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

**UNIT 2:** Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

**UNIT 3:** Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life(Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

**UNIT 4:** Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).

**UNIT 5:** Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

### Reference Books:

1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9<sup>th</sup> Edition, World Press.
3. Ramakumar R.: Technical Demography.
4. Pathak K. B. & Ram F.: Techniques of Demographic Analysis.
5. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3<sup>rd</sup> Edition. Prentice Hall of India Pvt. Ltd.
6. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag New York.
7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor

### III. MAJOR COURSE- MJ 14: LINEAR ALGEBRA

|   |  |
|---|--|
| <b>Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100</b> | <b>Pass Marks: Th (SIE + ESE) = 40</b> |
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(Credits: Theory-04) **60 Hours****Course Objectives & Learning Outcomes:**

This course will enable the students to:

1. Do the elementary row operations for the matrices and systems of linear equations.
2. Analyze the solution set of a system of linear equations.
3. Express a system of linear equations in a matrix form.
4. Generalize the concept of real/complex vector space to an arbitrary finite dimensional vector spaces.
5. Understand the concept of linear transformations.

**Course Content:**

**UNIT 1:** Different types of Matrices. Algebra of matrices. Different methods of finding inverse, Rank of a matrix, Echelon form of a matrix, Elementary transformations of a matrix, Elementary matrices, Invariance of rank under elementary transformations, Reduction to normal form, Equivalence of matrices, Rank of sum and product of matrices.

**UNIT 2:** Solution of a system of linear equations via matrix methods, Conditions for consistency and inconsistency. Matrix polynomials, Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a matrix. Cayley Hamilton theorem.

**UNIT 3:** Vector spaces, subspace, algebra of subspaces, linear combination of vectors, linear span, linear dependence and linear independence, basis and dimension, co-ordinate vector of a vector relative to a basis. Complement of a subspace, direct sum and quotient space.

**UNIT 4:** Linear transformations, null space, range space, rank and nullity of a linear transformation, Sylvester law of nullity. Matrix representation of a linear transformation, algebra of linear transformations.

**UNIT 5:** Isomorphism and related theorems, invertibility and isomorphism. Similarity of Matrix and Transformation. Diagonalizability and Quadratic forms.

**Reference Books:**

1. Linear Algebra – Hoffman & Kunze.
  2. Algebra, S. K. Mapa.
  3. Linear Algebra – Schaum's Outline.
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**IV. MAJOR COURSE- MJ 15:  
PRACTICALS-IV****Marks: Pr (ESE: 6Hrs) =100****Pass Marks: Pr (ESE) = 40**(Credits: Practicals-04) **120 Hours*****Instruction to Question Setter for******End Semester Examination (ESE):****There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:**Experiment* = 60 marks*Practical record notebook* = 15 marks*Viva-voce* = 25 marks**Practicals:**

1. Application problem based on Myre's and UN Indices.
2. Problem based on measures of Mortality.
3. To construct a complete life table.
4. Problem based on measures of Fertility.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
  2. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
  3. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9<sup>th</sup> Edition, World Press.
  4. Ramakumar R.: Technical Demography.
  5. Pathak K. B. & Ram F.: Techniques of Demographic Analysis.
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## SEMESTER VII

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### I. MAJOR COURSE- MJ 16: RESEARCH METHODOLOGY

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

#### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Understand the fundamentals of research and its methodologies.
2. Formulate research problems and hypotheses.
3. Design appropriate research strategies.
4. Understand methods of data collection and sampling.
5. Analyze data using statistical tools.
6. Interpret and communicate research findings effectively.
7. Prepare structured research reports and project proposals

#### **Course Content**

**UNIT 1:** Meaning and objectives of research, Types of research: basic, applied, quantitative, qualitative, Scientific method and research process, Role of statistics in research Identifying and defining research problems, Review of literature, Research questions and objectives, Formulation of hypotheses, Types of hypotheses: null and alternative

**UNIT 2:** Concepts of research design, features of a good design, Types of research design: exploratory, descriptive, experimental, cross-sectional, longitudinal. Control, randomization, replication

**UNIT 3:** Types of data: primary vs secondary, qualitative vs quantitative, Data collection tools: questionnaires, interviews, observation. Construction of questionnaires and schedules. Scaling techniques: nominal, ordinal, interval, ratio. Reliability and validity

**UNIT 4:** Editing, coding, tabulation. Descriptive statistics: tables, charts, measures of central tendency and dispersion. Inferential statistics: estimation, testing of hypotheses. Use of software (e.g., Excel, R, SPSS) in data analysis

**UNIT 5:** Interpretation of results, Structure of a research report, Referencing styles: APA/MLA, Common errors in report writing, Use of LaTeX or Word for writing research reports.

#### **Suggested Readings:**

1. R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques
  2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners
  3. Panneerselvam R., Research Methodology
  4. Jaspal Singh, Research Methodology and Statistical Techniques
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## II. MAJOR COURSE- MJ 17: MULTIVARIATE STATISTICAL ANALYSIS

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. The understanding of basic concepts associated with Multivariate Normal Distributions and their properties with special emphasis on Bivariate Normal Distribution.
2. Analyzing Multivariate data using data reduction techniques like Principal Component Analysis, Factor Analysis.
3. Classification method namely Discriminant Analysis.
4. Analyzing Multivariate data using data reduction techniques like Principal Component Analysis, Factor Analysis.
5. Classification method namely Discriminant Analysis.
6. Understand about fundamentals concepts of stochastic processes and Use notions of long-time behaviour including transience, recurrence and equilibrium in applied situations.
7. Testing of hypothesis using Non-Parametric test like Median test, Run test, Kruskal Wallis test etc.

### Course Content:

**UNIT 1:** Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN.

**UNIT 2:** Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.

**UNIT 3:** Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance- covariance matrix. Multiple and partial correlation coefficient and their properties.

**UNIT 4:** Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis. MANOVA.

**UNIT 5:** Non-parametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function. Kolmogorov Smirnov test for one sample, Sign tests- one sample and two samples, Wilcoxon-Mann-Whitney test, Kruskal-Wallis test.

### Reference Books:

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3<sup>rd</sup> Edn., John Wiley
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972): Multivariate Analysis, 1stEdn. Marcel Dekker.
4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6<sup>th</sup> Edn., Pearson & Prentice Hall
5. Mukhopadhyay, P.: Mathematical Statistics.
6. Gun A.M., Gupta M.K.: Das Gupta. B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
7. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2<sup>nd</sup> Edn. (Reprint) John Wiley and Sons.

### III. MAJOR COURSE- MJ 18: PRACTICALS-V

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) =100</b> | <b>Pass Marks: Pr (ESE) = 40</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-04) 120 Hours

**Instruction to Question Setter for****End Semester Examination (ESE):**

There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks

Practical record notebook = 15 marks

Viva-voce = 25 marks

**List of Practical**

1. Problem based on Principal Component Analysis
2. Problem based on Factor Analysis
3. Problem based on Discriminant Analysis
4. Problem based One-way MANOVA
5. Problem Based on Run test for randomness
6. Problem based on Kolmogrov Smirnov test
7. Problem based on Wilcoxon- Mann-Whitney test
8. Problem based on Kruskal- Walis test
9. Problem based on Sign test

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
  2. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4<sup>th</sup> Edition. Marcel Dekker, CRC.
  3. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3<sup>rd</sup> Edn., John Wiley
  4. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
  5. Kshirsagar, A.M. (1972): Multivariate Analysis, 1stEdn. Marcel Dekker.
  6. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6<sup>th</sup> Edn., Pearson & Prentice Hall
  7. Mukhopadhyay, P.: Mathematical Statistics.
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**IV. ADVANCED MAJOR COURSE- AMJ 1:  
BAYESIAN INFERENCE**

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

**(Only for Hons Degree)**

**Course Objectives & Learning Outcomes:**

1. Understand the Bayesian approach to statistical inference.
2. Specify appropriate prior distributions and interpret posterior distributions.
3. Perform Bayesian estimation and hypothesis testing.
4. Compare Bayesian and frequentist approaches.
5. Use computational methods (like MCMC) to solve complex Bayesian problems.

**Course Content:**

**UNIT 1:** Review of Basic Probability Concepts. Comparing Likelihood and Bayesian Approaches, Concept of Inverse Probability and Bayes Theorem.

**UNIT 2:** Classes of Prior Distributions. Conjugate Families for One Parameter Exponential Family Models, Models admitting sufficient statistics of fixed dimension.

**UNIT 3:** Generalized Maximum Likelihood Estimate. Types of Loss Functions. Bayes estimation under various loss functions. Posterior Risk. Bayesian interval estimation: Credible intervals, HPD intervals, Comparison with classical confidence intervals. Situation specific case studies to conduct posterior analysis.

**UNIT 4:** Prior and posterior odds. Bayes factor. Lindley's Paradox. Various types of testing hypothesis problems.

**UNIT 5:** Predictive density function, Regression Models.

**Suggested Readings:**

1. Aitchison, J. and Dunsmore, I.R. (1975). Statistical Prediction Analysis, Cambridge University Press.
  2. Box, G.E.P. and Tiao, G.C. (1973). Bayesian Inference in Statistical Analysis, Addison & Wesley.
  3. DeGroot, M.H. (1970). Optimal Statistical Decisions, McGraw Hill.
  4. Leonard, T. and Hsu, J.S.J. (1999). Bayesian Methods, Cambridge University Press.
  5. Lee, P. M. (1997). Bayesian Statistics: An Introduction, Arnold Press.
  6. Robert, C.P. (2001). The Bayesian Choice: A Decision Theoretic Motivation, 2<sup>nd</sup> ed., Springer Verlag.
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OR

RESEARCH COURSES- RC 1: (In lieu of AMJ 1)  
**RESEARCH PLANNING & TECHNIQUES**

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100****Pass Marks: Th (SIE + ESE) = 40**(Credits: Theory-04) **60 Hours****(Only for Hons with Research Degree)****Course Objectives & Learning Outcomes:**

1. Understand the stages of research planning and execution.
2. Develop research questions and design appropriate methodologies.
3. Select and apply statistical techniques relevant to the research goals.
4. Develop research proposals and understand funding mechanisms.
5. Analyze and interpret data using software tools.
6. Communicate research outcomes clearly in reports and presentations

**Course Content:**

**UNIT 1:** Meaning and importance of research planning, Characteristics of good research, Types of research: fundamental, applied, action, evaluation, Role of statistics in planning and decision-making, Research process: from idea to execution.

**UNIT 2:** Identifying a research gap, Formulating research problems and objectives, Conceptual framework, Developing research questions and hypotheses

**UNIT 3:** Components of research design, Types of design: exploratory, descriptive, experimental, and diagnostic, Operational definitions of variables, Time and resource planning (Gantt charts, timelines), Budgeting and cost estimation.

**UNIT 4:** Structure of a research proposal, writing objectives and methodology clearly, Preparing timelines and budgets, Sources of research funding (UGC, DST, CSIR, ICSSR, international), in proposal writing.

**UNIT 5:** Components of a good research report, writing results, discussion, and conclusions, Referencing styles and bibliography, Visual aids: tables, charts, graphs, Oral and poster presentations

**Suggested Readings:**

1. R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques
  2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners
  3. Panneerselvam R., Research Methodology
  4. Jaspal Singh, Research Methodology and Statistical Techniques
  5. Selected research papers from statistical journals
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## SEMESTER VIII

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### I. MAJOR COURSE- MJ 19: DESIGN & ANALYSIS OF EXPERIMENTS

**Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

(Credits: Theory-04) **60 Hours**

#### Course Objectives & Learning Outcomes:

This course will enable the students to:

1. The fundamental concepts of design of experiments.
2. The concepts of completely randomized design, Randomized block design and Latin square design
3. The concepts of balanced incomplete block design,
4. Total and partial confounded factorial design and identify the effects of different factors and their interactions and analyze factorial experiments.
5. The applications of completely randomized design, Randomized block design and latin square design,
6. The applications of balanced incomplete block design,
7. Total and partial confounded factorial design and identify the effects of different factors and their interactions and analyze factorial experiments on real life data.

#### Course Content:

**UNIT 1:** Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks.

**UNIT 2:** Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.

**UNIT 3:** Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties. Symmetric BIBD, Resolvable BIBD, Affine Resolvable BIBD, Intra Block analysis, complimentary BIBD, Residual BIBD, Dual BIBD, Derived BIBD.

**UNIT 4:** Factorial experiments: advantages, notations and concepts,  $2^2$ ,  $2^3$  and  $3^2$  factorial experiments, design and analysis.

**UNIT 5:** Total and Partial confounding for  $2^n$  ( $n \leq 5$ ),  $3^2$  and  $3^3$ . Factorial experiments in a single replicate.

#### Reference Books:

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
  2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
  3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.
  4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
  5. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
  6. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
  7. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8<sup>th</sup> Edn. World Press.
  8. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
  9. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.
  10. Dey Aloke (1986) : Theory of Block Design, Wiley Eastern.
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## II. MAJOR COURSE- MJ 20: PRACTICALS-VI

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) =100</b> | <b>Pass Marks: Pr (ESE) = 40</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-04) 120 Hours

**Instruction to Question Setter for****End Semester Examination (ESE):***There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:**Experiment = 60 marks**Practical record notebook = 15 marks**Viva-voce = 25 marks***List of Practical**

1. Analysis of a CRD
2. Analysis of an RBD
3. Analysis of an LSD
4. Analysis of an RBD with one missing observation
5. Analysis of an LSD with one missing observation
6. Intra Block analysis of a BIBD
7. Analysis of  $2^2$  and  $2^3$  factorial in CRD and RBD
8. Analysis of  $2^2$  and  $2^3$  factorial in LSD
9. Analysis of a completely confounded two level factorial design in 2 blocks
10. Analysis of a completely confounded two level factorial design in 4 blocks
11. Analysis of a partially confounded two level factorial design
12. Analysis of a single replicate of a  $2^n$  design
13. Analysis of a fraction of  $2^n$  factorial design

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
  2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
  3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.
  4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
  5. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4<sup>th</sup> Edition, McGraw Hill Companies.
  6. Kendall M.G. (1976): Time Series, Charles Griffin.
  7. Mukhopadhyay P. (2011): Applied Statistics, 2<sup>nd</sup> ed. Revised reprint, Books and Allied.
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### III. ADVANCED MAJOR COURSE- AMJ 2: STOCHASTIC PROCESSES & QUEUING THEORY

|   |  |
|---|--|
| <b>Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100</b> | <b>Pass Marks: Th (SIE + ESE) = 40</b> |
|---|--|

(Credits: Theory-04) **60 Hours****(Only for Hons Degree)****Course Objectives & Learning Outcomes:**

This course will enable the students to:

1. Understand about fundamentals concepts of stochastic processes and Use notions of long-time behaviour including transience, recurrence and equilibrium in applied situations.
2. Understand about Markov processes, Markov chains, Stability of Markov chains and Construct transition matrices for Markov dependent behaviour and summarize process information.
3. Understand the principles and objectives of model building based on Markov Chains.
4. Understand the concept of Queuing systems, Random walk and Classical ruin problem.

**Course Content:**

**UNIT 1:** Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.

**UNIT 2:** Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains, stability of Markov system, graph theoretic approach.

**UNIT 3:** Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Yule Furry process, birth and death process, pure death process.

**UNIT 4:** Queuing System: General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity, waiting time distribution (without proof).

**UNIT 5:** Gambler's Ruin Problem: Classical ruin problem, expected duration of the game.

**Reference Books:**

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
  2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
  3. Bhat, B.R. (2000): Stochastic Models: Analysis and Applications, New Age International Publishers.
  4. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.
  5. Feller, William (1968): Introduction to probability Theory and Its Applications, Vol I, 3<sup>rd</sup> Edition, Wiley International.
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#### IV. ADVANCED MAJOR COURSE- AMJ 3: PRACTICALS-VII

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) =100</b> | <b>Pass Marks: Pr (ESE) = 40</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-04) 120 Hours

(Only for Hons Degree)

**Instruction to Question Setter for****End Semester Examination (ESE):**

There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks

Practical record notebook = 15 marks

Viva-voce = 25 marks

**Practicals:**

**UNIT 1:** Poisson Process Simulation: Simulate arrival times using exponential inter-arrival times. Validate the properties of Poisson processes (independent increments, stationary increments).

**UNIT 2:** Birth and Death Process: Simulate Yule-Furry process and visualize growth. Simulate and plot sample paths of a general birth-death process.

**UNIT 3:** M/M/1 Queue Simulation: Simulate an M/M/1 queue (finite and infinite capacity). Analyze average waiting time, queue length, and server utilization.

**UNIT 4:** Steady-State Analysis: Compute and plot steady-state probabilities for M/M/1 system. Study the effect of arrival and service rates on system behaviour.

**UNIT 5:** Simulation of Gambler's Ruin: Simulate classical ruin problem using random walks. Compute the probability of ruin and expected duration of the game for different starting capitals and win probabilities.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.  
However, Use of Smartphone or Web is restricted in the Examination

**Reference Books:**

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
3. Bhat, B.R. (2000): Stochastic Models: Analysis and Applications, New Age International Publishers.
4. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.
5. Feller, William (1968): Introduction to probability Theory and Its Applications, Vol I, 3<sup>rd</sup> Edition, Wiley International

## V. RESEARCH COURSES- RC 2: (In lieu of AMJ 2 &amp; AMJ 3)

**RESEARCH/ PROJECT DISSERTATION/ RESEARCH INTERNSHIP/ FIELD WORK**

|   |                        |
|---|------------------------|
| <b>Marks: 50 (SIE: 25 Synopsis + 25 Viva on Synopsis: 1Hr) + 100 (ESE Pr: 6Hrs) + 50 (Viva) = 200</b> | <b>Pass Marks = 80</b> |
|---|------------------------|

**(Only for Hons with Research Degree)****Guidelines to Examiners for Semester Internal Examination (SIE):***Evaluation of project dissertation work may be as per the following guidelines:**Project Synopsis* = 25 marks*Project Synopsis presentation and viva-voce* = 25 marks**Guidelines to Examiners for End Semester Examination (ESE):***Evaluation of project dissertation work may be as per the following guidelines:**Project model (if any) and the Project record notebook* = 70 marks*Project presentation and viva-voce* = 30 marks*The overall project dissertation may be evaluated under the following heads:*

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in an Internship programme with a reputed organization
- Application of the Research technique in Data collection
- Report Presentation
- Presentation style
- Viva-voce

**Research Project**

Research project under a Supervisor of the Department/Institution may be allocated to the eligible and qualifying candidate.

**Project Dissertation/ Research Internship/ Field Work**

The students of Post-Graduation must work Thirty-Six (36) days as Interns under Any Organisation having an MoU with the Ranchi University, which may include Government Organizations/judiciary/ Health Care Sectors/ Educational Institutions/ NGOs etc.

- The nature and the place of working must be informed in writing, seeking permission from the head of the department or the institution before undertaking the Project dissertation.

**Submission of the Project Work**

Each student has to submit two copies of the dissertation work duly forwarded by the HOD of the Department concerned. The forwarded copies will be submitted to the Department/Institution for evaluation at least seven days before the seminar.

The Project Report will consist of:

- a. Field work/Lab work related to the project.
- b. Preparation of the dissertation based on the work undertaken.
- c. Presentation of project work in the seminar on the assigned topic & open viva there on.
- d. At least one Research paper must be presented at a conference or may be published in a reputed journal.

**Topics**

Project work related to the Industrial/socially relevant topics may be given.

**NB:** Students will select topics for the project work in consultation with a teacher of the department.

The seminar will be held in the respective University Department at Ranchi University, Ranchi.

## COURSES OF STUDY FOR FYUGP IN “STATISTICS” MINOR

**ASSOCIATED CORE COURSE- MN-A****Either may be opted in Sem-I or Sem-II****I. ASSOCIATED CORE COURSE- MN-A:  
INTRODUCTORY STATISTICS****Marks: 25 (15 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100****Pass Marks: Th (SIE + ESE) = 40****(Credits: Theory-03) 45 Hours****Course Objectives & Learning Outcomes:**

This course will enable the students to:

1. Familiarize with various Statistical Data Analysis tools that can be used for effective decision making. Emphasis will be on the application of the concepts learnt.
2. Enable the students with basic idea of dealing with observations/ data through the techniques of Descriptive Statistics including measures of central tendency, Dispersion, Correlation and Regression.

**Course Content:****UNIT 1:** Introduction: Definition of Statistics, Importance and Scope of Statistics.**UNIT 2:** Measures of Central Tendency: Meaning of central tendency, Common measures of central tendency, Relationship among A.M, G.M and H.M, Weighted means, Quartiles, Deciles, and Percentiles.**UNIT 3:** Measures of Dispersion: Common measures of absolute dispersion, Comparisons of different absolute measures, properties of standard deviation, Measures of relative dispersion.**UNIT 4:** Moments, Different types of moments and their relationships, Skewness and Kurtosis: Meaning of Skewness and Kurtosis, different measures of skewness and kurtosis.**UNIT 5:** Bivariate data: Definition, scatter diagram, Karl Pearson's product moment correlation coefficient and its properties, simple linear regression, Principle of least squares and fitting of regression curves.**Reference Books:**

1. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8<sup>th</sup> Edn. The World Press, Kolkata.
2. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor.

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**MINOR COURSE-B**


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**I. MINOR COURSE- MN-B:  
INTRODUCTORY PROBABILITY**
**Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75**
**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

 (Credits: Theory-03) **45 Hours**
**Course objectives & Learning Outcomes:**

This course will enable the students to:

1. Learn the concept of various approaches of probability.
2. Calculate probabilities using probability laws and theoretical results.
3. Understand the concept of random variable and probability distributions.
4. Identify an appropriate probability distribution for a given random variable and use its properties to calculate probabilities.
5. Apply the Chebyshev's inequality and central limit theorem to calculate approximate probabilities for sample means.

**Course Content:**
**UNIT 1:** Introduction, random experiments, sample space, events and algebra of events.

**UNIT 2:** Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

**UNIT 3:** Random Variables: Discrete and continuous random variables, p.m.f., p.d.f., c.d.f. Illustrations of random variables and its properties. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f. and p.d.f.

**UNIT 4:** Mathematical expectation, variance, moments and moment generating function and its Properties. Chebyshev's inequality, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.).

**UNIT 5:** Standard probability distributions: Uniform(discrete), Binomial, Poisson, geometric, uniform(continuous), normal, exponential along with their properties and limiting/approximation cases.

**Reference Books:**

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
  2. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor.
  3. Gun, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I (2005).
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## II. MINOR COURSE- MN-B PR: INTRODUCTORY PROBABILITY PRACTICALS

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) = 25</b> | <b>Pass Marks: Pr (ESE) = 10</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-01) **30 Hours****Instruction to Question Setter for****End Semester Examination (ESE):***There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:**Experiment = 15 marks**Practical record notebook = 05 marks**Viva-voce = 05 marks***Practicals:****UNIT 1:** Fitting of binomial distributions for  $n$  and  $p = q = \frac{1}{2}$ . Fitting of binomial distributions for given  $n$  and  $p$ . Fitting of binomial distributions after computing mean and variance.**UNIT 2:** Fitting of Poisson distributions for given value of  $\lambda$ . Fitting of Poisson distributions after computing mean.**UNIT 3:** Fitting of suitable distribution. Application problems based on binomial distribution. Application problems based on Poisson distribution.**UNIT 4:** Problems based on area property of normal distribution. To find the ordinate for a given area for normal distribution. Application based problems using normal distribution. Fitting of normal distribution when parameters are given. Fitting of normal distribution when parameters are not given.**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination

**Reference Books:**

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
  2. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor.
  3. Gun, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I (2005)
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**MINOR COURSE-C**


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**I. MINOR COURSE- MN-C:  
STATISTICAL INFERENCE**
**Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75**
**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

 (Credits: Theory-03) **45 Hours**
**Course objectives & Learning Outcomes:**

This course will enable the students to:

1. Gain insight regarding the population parameters from the observed data.
2. Estimate the sample to sample variation or uncertainty.
3. Provide estimates of unknown parameters from sample statistics.
4. Quantify the chance of obtaining a particular random sample result if the null hypothesis were true.

**Course Content:**
**UNIT 1:** Estimation: Problem of estimation, Properties of a good estimator - unbiasedness, consistency, efficiency and sufficiency. Factorization theorem (Without proof).

**UNIT 2:** Basic terminologies in hypothesis testing: Parameter and Statistic, Null and Alternative hypotheses, critical region, level of significance, one tailed and two tailed tests, errors in hypothesis testing and power of a statistical test. Procedure for testing of hypothesis.

**UNIT 3:** Large sample tests: Test of significance for single proportion, difference of two proportions, single mean, difference of two means, Non-parametric tests: tests of association and goodness of fit using Chi- square test, Sign test, Wilcoxon two-sample test.

**UNIT 4:** Analysis of variance: one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block.

**UNIT 5:** Analysis of completely randomized design, randomized complete block design.

**Reference Books:**

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).
  2. Gun, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).
  3. Das, M. N. & Giri, N. C.: Design and analysis of experiments. John Wiley.
  4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences. (1964, 1977) by John Wiley.
  5. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
  6. Goldstein, A Biostatistics-An introductory text (1971). The Macmillan New York.
  7. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
  7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.
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## II. MINOR COURSE- MN-C PR: STATISTICAL INFERENCE PRACTICALS

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) = 25</b> | <b>Pass Marks: Pr (ESE) = 10</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-01) **30 Hours*****Instructions to Question Setter for******End Semester Examination (ESE):****There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:**Experiment* = 15 marks*Practical record notebook* = 05 marks*Viva-voce* = 05 marks**Practicals:**

1. Problem based on sign test
2. Problem based on goodness of fit test
3. Problem based on test of single proportions
4. Problem based on test of difference of two means
5. Problem based on test of single mean
6. Problem based on test of difference of two means
7. Analysis of a CRD
8. Analysis of an RBD

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination

**Reference Books:**

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005).
  2. Das, M. N. & Giri, N. C.: Design and analysis of experiments. John Wiley.
  3. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences. (1964, 1977) by John Wiley.
  4. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
  5. Goldstein, A Biostatistics-An introductory text (1971). The Macmillan New York.
  6. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
  7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.
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**MINOR COURSE-D**


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**I. MINOR COURSE- MN-D:  
LINEAR MODELS**
**Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75**
**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

 (Credits: Theory-03) **45 Hours**
**Course objectives & Learning Outcomes:**

This course will enable the students to:

1. Develop a deeper understanding of the linear regression model.
2. Define the explanatory variable as the independent variable (predictor), and the response variable as the dependent variable (predicted).
3. When describing the association between two numerical variables, evaluate
  - a. direction: positive ( $x \uparrow, y \uparrow$ ), negative ( $x \downarrow, y \uparrow$ )
  - b. form: linear or not
  - c. strength: determined by the scatter around the underlying relationship.
4. Define correlation as the linear association between two numerical variables.
5. Define the least squares line as the line that minimizes the sum of the squared residuals, and list conditions necessary for fitting such line: (1) linearity, (2) nearly normal residuals, (3) constant variability.

**Course Content:**
**UNIT 1:** Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

**UNIT 2:** Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.

**UNIT 3:** Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models,

**UNIT -IV:** Analysis of variance and covariance in two way classified data with one observation per cell for fixed effect models.

**UNIT 5:** Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.

**Reference Books:**

1. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
  2. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4<sup>th</sup> Edition, McGraw Hill Companies.
  3. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
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## II. MINOR COURSE- MN-D PR: LINEAR MODELS PRACTICALS

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) = 25</b> | <b>Pass Marks: Pr (ESE) = 10</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-01) **30 Hours****Instructions to Question Setter for****End Semester Examination (ESE):**

There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks

Practical record notebook = 05 marks

Viva-voce = 05 marks

**Practicals:**

1. Maximum Likelihood Estimation.
2. Method of Moment Estimation.
3. ANOVA in one way classified data for fixed effect model
4. ANOCOVA in one way classified data for fixed effect model
5. Problems based on simple regression model and multiple regression model.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6<sup>th</sup> Edition, Wiley India Pvt. Ltd.
  2. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8<sup>th</sup> Edn. The World Press, Kolkata.
  3. Mitra, A.: Statistical Quality Control and Improvement, Wiley India Pvt. Ltd.
  4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
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**MINOR COURSE-E**


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**I. MINOR COURSE- MN-E:  
DEMOGRAPHY AND VITAL STATISTICS**
**Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75**
**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

 (Credits: Theory-03) **45 Hours**
**Course Objectives & Learning Outcomes:**

1. Distinction between Vital Statistics and Demography.
2. To check the completeness of registration data using Chandrasekharan –Deming formula.
3. Use Myers' and UN indices in evaluating age data.
4. Use of Balancing Equations.
5. Population Composition and Dependency Ratio.
6. Basic measures of Mortality, Fertility, Life tables, their construction and uses, and Concept of Abridged life and their construction by Reed and Merrell method and Concept of Stable and Stationary Populations.
7. Basic measures of Fertility and Measures of Population Growth.

**Course Content:**

**UNIT 1:** Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

**UNIT 2:** Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

**UNIT 3:** Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life(Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

**UNIT 4:** Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).

**UNIT 5:** Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

**Reference Books:**

1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
  2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9<sup>th</sup> Edition, World Press.
  3. Ramakumar R.: Technical Demography.
  4. Pathak K. B. & Ram F.: Techniques of Demographic Analysis.
  5. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3<sup>rd</sup> Edition. Prentice Hall of India Pvt. Ltd.
  6. Keyfitz N., Beckman John A.: Demogrphy through Problems S-Verlag New York.
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**II. MINOR COURSE- MN-E PR:  
DEMOGRAPHY AND VITAL STATISTICS PRACTICALS**

**Marks: Pr (ESE: 6Hrs) = 25**

**Pass Marks: Pr (ESE) = 10**

(Credits: Practicals-01) **30 Hours**

***Instructions to Question Setter for***

***End Semester Examination (ESE):***

*There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:*

*Experiment = 15 marks*

*Practical record notebook = 05 marks*

*Viva-voce = 05 marks*

**Practicals:**

1. Application problem based on Myre's and UN Indices.
2. Problem based on measures of Mortality.
3. To construct a complete life table.
4. Problem based on measures of Fertility.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
  2. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
  3. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9<sup>th</sup> Edition, World Press.
  4. Ramakumar R.: Technical Demography.
  5. Pathak K. B. & Ram F.: Techniques of Demographic Analysis.
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**MINOR COURSE-F**

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**I. MINOR COURSE- MN-F:  
TIMES SERIES ANALYSIS****Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75****Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40****(Credits: Theory-03) 45 Hours****Course Objectives & Learning Outcomes:**

This course will enable the students to:

1. The components and forecast values of a time series at future time points.
2. The concept of Moving -average(MA) process, Autoregressive(AR) process of order and two.
3. The concept of short term forecasting method: Brown's discounted regression, Box-Jenkins method.
4. The concepts of Stationary time series: Weak stationarity, autocorrelation function and correlogram of moving average.

**Course Content:**

**UNIT 1:** Introduction to times series data, application of time series to various fields, Components of a times series, Decomposition of a time series. Trend: Estimation of trend by free hand curve method, method of semi averages, fitting various mathematical curves, and growth curves.

**UNIT 2:** Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series.

**UNIT 3:** Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend. Ratio to Moving Averages and Link Relative method, Deseasonalization.

**UNIT 4:** Cyclic Component: Harmonic Analysis. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.

**UNIT 5:** Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods: Box-Jenkins method. Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average.

**Reference Books:**

1. Kendall M.G. (1976): Time Series, Charles Griffin.
  2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
  3. Mukhopadhyay P. (2011): Applied Statistics, 2<sup>nd</sup> ed. Revised reprint, Books and Allied.
  4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
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## II. MINOR COURSE- MN F PR: TIMES SERIES ANALYSIS PRACTICALS

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) = 25</b> | <b>Pass Marks: Pr (ESE) = 10</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-01) **30 Hours*****Instruction to Question Setter for******End Semester Examination (ESE):***

*There will be one Practical Examination of 6Hrs duration. Evaluation of the Practical Examination may be as per the following guidelines:*

|                   |                   |
|-------------------|-------------------|
| <i>Experiment</i> | <i>= 15 marks</i> |
|-------------------|-------------------|

|                                  |                   |
|----------------------------------|-------------------|
| <i>Practical record notebook</i> | <i>= 05 marks</i> |
|----------------------------------|-------------------|

|                  |                   |
|------------------|-------------------|
| <i>Viva-voce</i> | <i>= 05 marks</i> |
|------------------|-------------------|

**Practicals:**

**UNIT 1:** Problems based on estimation of trend by free hand curve method, method of semi averages, fitting various mathematical curves, and growth curves

**UNIT 2:** Problem based on estimation of seasonal component by Method of simple averages, Ratio to Trend. Ratio to Moving Averages

**UNIT 3:** Moving-average (MA) process and Autoregressive (AR) process of orders one and two

**UNIT 4:** Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.

**UNIT 5:** Problem based on Forecasting

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Kendall M.G. (1976): Time Series, Charles Griffin.
  2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
  3. Mukhopadhyay P. (2011): Applied Statistics, 2<sup>nd</sup> ed. Revised reprint, Books and Allied.
  4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor
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**MINOR COURSE-G**


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**I. MINOR COURSE- MN G:  
STATISTICAL QUALITY CONTROL**
**Marks: 15 (15 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75**
**Pass Marks: Th (SIE + ESE) + Pr (ESE) = 40**

 (Credits: Theory-03) **45 Hours**
**Course Objectives & Learning Outcomes:**

This course will enable the students to

1. Understand the meaning of quality.
2. Understand the control of a process.
3. Statistical process control tools-control charts for variable, attributes.
4. Understand about the capability of a process.
5. Statistical product control tools-sampling inspection plans.
6. Know about the Organizational structure of Six sigma.

**Course Content:**

**UNIT 1:** Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3- $\sigma$  Control charts, Rational Sub-grouping.

**UNIT 2:** Control charts for variables: X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes.

**UNIT 3:** Acceptance sampling plan: Principle of acceptance sampling plans.

**UNIT 4:** Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.

**UNIT 5:** Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM). Organizational Structure and Six Sigma training plans- Selection Criteria for Six-Sigma roles and training plans

**Reference Books:**

1. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
  2. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8<sup>th</sup> Edn. The World Press, Kolkata.
  3. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
  4. Montgomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3<sup>rd</sup> Edition reprint, Wiley India Pvt. Ltd.
  5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2<sup>nd</sup> Edition, St. Lucie Press.
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## II. MINOR COURSE- MN G PR: STATISTICAL QUALITY CONTROL PRACTICALS

|                                   |                                  |
|-----------------------------------|----------------------------------|
| <b>Marks: Pr (ESE: 6Hrs) = 25</b> | <b>Pass Marks: Pr (ESE) = 10</b> |
|-----------------------------------|----------------------------------|

(Credits: Practicals-01) **30 Hours****Instruction to Question Setter for****End Semester Examination (ESE):***There will be one Practical Examination of 6Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:**Experiment* = 15 marks*Practical record notebook* = 05 marks*Viva-voce* = 05 marks**Practicals:**

1. Problem based on X- bar & R –chart.
2. Problem based on X-bar & s-chart.
3. Problem based on np-chart & p-chart.
4. Problem based on c-chart and u-chart.
5. Problem based on Indices of Acceptance Sampling Plans.
6. Construction and Interpretation of OC, AOQ, ATI and ASN curves for single and double sampling inspection plans.
7. Calculation of process capability and comparison of 3- sigma control limits with specification limits.

**Note:**

1. Use of Scientific Calculator will be Allowed in Practical Examination.
2. MS Excel/ or Any Statistical Software and Computer System may be provided by the Institution.
3. However, Use of Smartphone or Web is restricted in the Examination.

**Reference Books:**

1. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6<sup>th</sup> Edition, Wiley India Pvt. Ltd.
  2. Gun A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8<sup>th</sup> Edn. The World Press, Kolkata.
  3. Mitra, A.: Statistical Quality Control and Improvement, Wiley India Pvt. Ltd.
  4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.
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