FYUGP

STATISTICS HONOURS/ RESEARCH

FOR UNDER GRADUATE COURSES UNDER RANCHI UNIVERSITY

Upgraded & Implemented from 3rd Semester of Academic Session 2022-26
& From 1st Semester of Session 2023-27 Onwards

UNIVERSITY DEPARTMENT OF MATHEMATICS
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Ref. **Date:** 30.08.2023

B.O.S. for FYUGP Statistics

Name of the Teacher of Board of studies for preparation of NEP 2020 FYUGP syllabus of statistics.

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DIRECTOR
IQAC, RANCHI UNIVERSITY
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Table of Content

Students are Instructed to

Refer Syllabus of Allied/ Opted Subjects from R.U. Website

HIGHLIGHTS OF REGULATIONS OF FYUGP

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 **1st of July**.

ELIGIBILITY

- The selection for admission will be primarily based on availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if 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 overall 75% marks (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 maximum for Seven years from the date of registration.

ACADEMIC CALENDAR

- An Academic Calendar will be prepared by the university to maintain uniformity in the CBCS of the UG Honours Programmes, UG Programmes, semesters and courses in the college run 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, course work, conduct of examination and declaration of results including semester break.
- In order to undergo 8 weeks' summer internship/ apprenticeship during the summer camp, the Academic Calendar may be scheduled for academic activities as below:
  a) Odd Semester: **From first Monday of August to third Saturday of December**
  b) Even Semester: **From first Monday of January to 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 endeavors 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 first and second semester.,
  - 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 first year or second year summer term in addition to 9 credits from skill-based courses earned during 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 Degree (Honours with Research) after a 4-year (8 semesters) programme of study to the students undertaking 12 credit Research component in 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 the duration of a semester (minimum 15 weeks).

a) One hour of teaching/ lecture or two hours of laboratory /practical work will be assigned per class/interaction.
   One credit for Theory = 15 Hours of Teaching i.e., 15 Credit Hours
   One credit for Practicum = 30 Hours of Practical work i.e., 30 Credit Hours

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 two-hour duration.

CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

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

PROMOTION CRITERIA

First degree programme with single major:

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 Courses in an academic year, a student has to pass in minimum 9 papers out of the total 12 papers.
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 18 papers out of the total 24 papers.
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 26 papers out of the total 34 papers.
vi. However, it will be necessary to procure pass marks in each of the paper before completion of the course.

First degree programme with dual major:

vii. Above criterions are applicable as well on the students pursuing dual degree programmes however first degree programme will remain independent of the performance of the student in dual major courses.
viii. To get eligible for taking ESE, a student will be required to pass in at least 75% of Courses in an academic year.
ix. A student has to pass in minimum 3 papers out of the total 4 papers.
x. It will be a necessity to clear all papers of second major programme in second attempt in succeeding session, failing which the provision of dual major will be withdrawn and the student will be entitled for single first degree programme.

PUBLICATION OF RESULT

- The result of the examination shall be notified by the Controller of Examinations of the University in different newspapers and also on University website.
- If a student is found indulged in any kind of malpractice/ unfair means during 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 next coming 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 for clearing the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination for clearing the backlog.

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

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COURSE STUCTURE FOR FYUGP **'HONOURS/ RESEARCH'**

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 160]

Level of Courses	**Semester**	**MJ**; Discipline Specific Courses – Core or Major (80)	**MN**; Minor from discipline (16)	**MN**; Minor from vocational (16)	**MDC**; Multidisciplinary Courses [Life sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.] (9)	**AEC**; Ability Enhancement Courses (Modern Indian Language and English) (8)	**SEC**; Skill Enhancement Courses (9)	**VAC**; Value Added Courses (6)	**IAP**; Internship/ Dissertation (4)	**RC**; Research Courses (12)	**AMJ**; Advanced Courses in lieu of Research (12)	**Credits**	**Double Major (DMJ)**
1	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	**I**	4	4		3	2	3	4				**20**	4+4
	II	4+4		4	3	2	3					**20**	4+4
	Exit Point: Undergraduate Certificate provided with Summer Internship/ Project (4 credits)												
200-299: Intermediate-level courses	**III**	4+4	4		3	2	3					**20**	4+4
	IV	4+4+4		4		2		2				**20**	4+4
	Exit Point: Undergraduate Diploma provided with Summer Internship in 1st or 2nd year/ Project (4 credits)												
300-399: Higher-level courses	**V**	4+4+4	4						4			**20**	4+4
	VI	4+4+4+4		4								**20**	4+4
	Exit Point: Bachelor's Degree												
400-499: Advanced courses	**VII**	4+4+4+4	4									**20**	4+4
	VIII	4		4						12	4+4+4	**20**	4+4
	Exit Point: Bachelor's Degree with Hons. /Hons. with Research											**160**	**224**

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

Upgraded & Implemented from 3rd Sem. of Session 2022-26 & 1st Sem. of Session 2023-27 Onwards

Table 2: Semester wise Course Code and Credit Points for Single Major:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		
	Code	**Papers**	**Credits**
I	AEC-1	Language and Communication Skills (MIL 1 - Hindi/ English)	2
	VAC-1	Value Added Course-1	4
	SEC-1	Skill Enhancement Course-1	3
	MDC-1	Multi-disciplinary Course-1	3
	MN-1A	Minor from Discipline-1	4
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	4
II	AEC-2	Language and Communication Skills (MIL 2 - English/ Hindi)	2
	SEC-2	Skill Enhancement Course-2	3
	MDC-2	Multi-disciplinary Course-2	3
	MN-2A	Minor from Vocational Studies/Discipline-2	4
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	4
III	AEC-3	Language and Communication Skills (Language Elective 1 - Modern Indian language including TRL)	2
	SEC-3	Skill Enhancement Course-3	3
	MDC-3	Multi-disciplinary Course-3	3
	MN-1B	Minor from Discipline-1	4
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	4
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	4
IV	AEC-3	Language and Communication Skills (Language Elective - Modern Indian language including TRL)	2
	VAC-2	Value Added Course-2	2

	MN-2B	Minor from Vocational Studies/Discipline-2	4
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	4
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	4
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	4
V	MN-1C	Minor from Discipline-1	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
	IAP	Internship/Apprenticeship/Field Work/Dissertation/Project	4
VI	MN-2C	Minor from Vocational Studies/Discipline-2	4
	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
VII	MN-1D	Minor from Discipline-1	4
	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
	MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)	4
VIII	MN-2D	Minor from Vocational Studies/Discipline-2	4
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4
	RC/ AMJ-1 AMJ-2 AMJ-3	Research Internship/Field Work/Dissertation OR Advanced Major paper-1 (Disciplinary/Interdisciplinary Major) Advanced Major paper-2 (Disciplinary/Interdisciplinary Major) Advanced Major paper-3 (Disciplinary/Interdisciplinary Major)	12/ 4 4 4
		Total Credit	**160**

NUMBER OF CREDITS BY TYPE OF COURSE

The hallmark of the new curriculum framework is the flexibility for the students to learn courses of their choice across various branches of undergraduate programmes. This requires that all departments prescribe a certain specified number of credits for each course and common instruction hours (slot time).

Table 3: Overall Course Credit Points for Single Major

Courses	Nature of Courses	3 yr UG Credits	4 yr UG Credits
Major	Core courses	60	80
Minor	i. Discipline/ Interdisciplinary courses and ii. Vocational Courses	24	32
Multidisciplinary	3 Courses	9	9
AEC	Language courses	8	8
SEC	**Courses to be developed by the University**	9	9
Value Added Courses	Understanding India, Environmental Studies, Digital Education, Health & wellness, Summer Internship/ Apprenticeship/ Community outreach activities, etc.	6	6
Internship (In any summer vacation for Exit points or in Semester-V)		4	4
Research/ Dissertation/ Advanced Major Courses	Research Institutions/ 3 Courses		12
	Total Credits =	**120**	**160**

Table 4: Overall Course Code and Additional Credit Points for Double Major

Courses	Nature of Courses	3 yr UG Credits	4 yr UG Credits
Major 1	Core courses	60	80
Major 2	Core courses	48	64
Minor	i. Discipline/ Interdisciplinary courses and ii. Vocational Courses	24	32
Multidisciplinary	3 Courses	9	9
AEC	Language courses	8	8
SEC	**Courses to be developed by the University**	9	9
Value Added Courses	Understanding India, Environmental Studies, Digital Education, Health & wellness, Summer Internship/ Apprenticeship/ Community outreach activities, etc.	6	6
Internship (In any summer vacation for Exit points or in Semester-V)		4	4
Research/ Dissertation/ Advanced Major Courses	Research Institutions/ 3 Courses		12
	Total Credits =	**168**	**224**

Table 5: Semester wise Course Code and Additional Credit Points for Double Major:

Semester	Double Major Courses		
	Code	Papers	Credits
I	DMJ-1	Double Major paper-1 (Disciplinary/Interdisciplinary Major)	4
	DMJ-2	Double Major paper-2 (Disciplinary/Interdisciplinary Major)	4
II	DMJ-3	Double Major paper-3 (Disciplinary/Interdisciplinary Major)	4
	DMJ-4	Double Major paper-4 (Disciplinary/Interdisciplinary Major)	4
III	DMJ-5	Double Major paper-5 (Disciplinary/Interdisciplinary Major)	4
	DMJ-6	Double Major paper-6 (Disciplinary/Interdisciplinary Major)	4
IV	DMJ-7	Double Major paper-7 (Disciplinary/Interdisciplinary Major)	4
	DMJ-8	Double Major paper-8 (Disciplinary/Interdisciplinary Major)	4
V	DMJ-9	Double Major paper-9 (Disciplinary/Interdisciplinary Major)	4
	DMJ-10	Double Major paper-10 (Disciplinary/Interdisciplinary Major)	4
VI	DMJ-11	Double Major paper-11 (Disciplinary/Interdisciplinary Major)	4
	DMJ-12	Double Major paper-12 (Disciplinary/Interdisciplinary Major)	4
VII	DMJ-13	Double Major paper-13 (Disciplinary/Interdisciplinary Major)	4
	DMJ-14	Double Major paper-14 (Disciplinary/Interdisciplinary Major)	4
VIII	DMJ-15	Double Major paper-15 (Disciplinary/Interdisciplinary Major)	4
	DMJ-16	Double Major paper-16 (Disciplinary/Interdisciplinary Major)	4
		Total Credit	**64**

Abbreviations:

AEC	Ability Enhancement Courses
SEC	Skill Enhancement Courses
IAP	Internship/Apprenticeship/ Project
MDC	Multidisciplinary Courses
MJ	Major Disciplinary/Interdisciplinary Courses
DMJ	Double Major Disciplinary/Interdisciplinary Courses
MN	Minor Disciplinary/Interdisciplinary Courses
AMJ	Advanced Major Disciplinary/Interdisciplinary Courses
RC	Research Courses

AIMS OF BACHELOR'S DEGREE PROGRAMME IN STATISTICS

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 programme learning outcomes relating to Honours/Research Degree in Statistics:

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 MAJOR-1 FOR FYUGP **2022 onwards**

Table 7: Semester wise Examination Structure in Discipline Courses:

Semester	Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	Descriptive Statistics and Index Numbers	4	25	75	---
II	MJ-2	Probability Theory	4	25	75	---
	MJ-3	**Practical-I**	4	---	---	100
III	MJ-4	Sampling Distributions	4	25	75	---
	MJ-5	**Practical-II**	4	---	---	100
IV	MJ-6	Statistical Inference	4	25	75	---
	MJ-7	Survey Sampling	4	25	75	---
	MJ-8	**Practical-III**	4	---	---	100
V	MJ-9	Statistical Quality Control	4	25	75	---
	MJ-10	Real Analysis	4	25	75	---
	MJ-11	**Practical-IV**	4	---	---	100
VI	MJ-12	Linear Models	4	25	75	---
	MJ-13	Demography & Vital Statistics	4	25	75	---
	MJ-14	Linear Algebra	4	25	75	---
	MJ-15	**Practical-V**	4	---	---	100
VII	MJ-16	Multivariate Statistical Analysis and Non-Parametric Methods	4	25	75	---
	MJ-17	Operations Research	4	25	75	---
	MJ-18	Stochastic Processes and Queuing Theory	4	25	75	---
	MJ-19	**Practical-VI**	4	---	---	100
VIII	MJ-20	Design & Analysis of Experiments	4	25	75	---
	AMJ-1	Econometrics	4	25	75	---
	AMJ-2	Time Series Analysis	4	25	75	---
	AMJ-3	**Practical-VII**	4	---	---	100
	or RC-1	Research Methodology	4	25	75	---
	RC-2	Project Dissertation/ Research Internship/ Field Work	8	---	---	200
		Total Credit	**92**			

Table 8: Semester wise Course Code and Credit Points for Skill Enhancement Courses:

Semester	Skill Enhancement Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	SEC-1	Numerical Analysis	3	---	75	---
II	SEC-2	Reliability & Survival Analysis	3	---	75	---
III	SEC-3	Elementary Computer Application Softwares	3	---	75	---
		Total Credit	**9**			

Table 9: Semester wise Course Code and Credit Points for Minor Courses:

Semester	Minor Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MN-1A	Introductory Statistics	4	15	60	25
III	MN-1B	Introductory Probability	4	15	60	25
V	MN-1C	Statistical Inference and ANOVA	4	15	60	25
VII	MN-1D	Applied Statistics	4	15	60	25
		Total Credit	**16**			

INSTRUCTION TO QUESTION SETTER

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 60 marks):

There will be two groups 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.

B. (ESE 75 marks):

There will be two groups 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.

C. (ESE 100 marks):

There will be two groups 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 SEMESTER INTERNAL EXAMINATION

Question format for **10 Marks**:

Subject/ Code

F.M. =10 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [5]
3. ..... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATION

Question format for **50 Marks**:

Subject/ Code

F.M. =50 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **60 Marks**:

Subject/ Code

F.M. =60 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **75 Marks**:

Subject/ Code

F.M. = 75 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **100 Marks**:

Subject/ Code

F.M. = 100 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

Note: There may be subdivisions in each question asked in Theory Examination.

SEMESTER I

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-I: 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-II: 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. 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-III: 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-IV: 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

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

(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-I: Error in approximations: Approximate numbers and significant figures, Error and their computation, Propagation of Errors, General Formula of Errors.

UNIT-II: 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-III: Calculus of finite difference: The operators Δ, ∇, E, factorial notation, their properties and inter-relation between them, Fundamental theorem of difference calculus, divided differences. 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

SEMESTER II

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-I: 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-II: 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-III: Mathematical Expectation: Expectation of univariate and bivariate random variables and its properties. Conditional expectations. 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-IV: 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.

II. MAJOR COURSE- MJ 3:
PRACTICALS-I:

Marks: Pr (ESE: 3Hrs) =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 3Hrs 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. Graphical representation of data.
2. Problems based on measures of central tendency, dispersion, coefficient of variation, moments, skewness and kurtosis.
3. Karl Pearson correlation coefficient.
4. Correlation coefficient for a bivariate frequency distribution.
5. Spearman rank correlation with and without ties.
6. Partial and multiple correlations.
7. Lines of regression, angle between lines and estimated values of variables.
8. Fitting of polynomials, exponential curves.
9. To calculate price and quantity index numbers using different formulae.
10. To calculate the Chain Base index numbers.
11. To calculate consumer price index number.
12. Problem based on consistency of attributes.
13. To measure association and independence of attributes.
14. Fitting of binomial distribution.
15. Fitting of Poisson distribution.
16. Fitting of negative binomial.
17. Fitting of suitable distribution.
18. Application problems based on binomial distribution.
19. Application problems based on Poisson distribution.
20. Application problems based on negative binomial distribution.
21. Problems based on area property of normal distribution.
22. To find the ordinate for a given area for normal distribution.
23. Application based problems using normal distribution.
24. Fitting of normal distribution when parameters are given.
25. 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. 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.
6. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor

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III. SKILL ENHANCEMENTCOURSE- SEC 2:
RELIABILITY & SURVIVAL ANALYSIS

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

(Credits: Theory-03) **45 Hours**

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Study the properties of measurement scales and the items that compose the scales.
2. Estimate and interpret survival and/or hazard functions from the survival data.
3. Compare survival and /or hazard functions.
4. Assess the relationship of explanatory variables to survival time.

Course Content:

UNIT-I: Survival function, Hazard function, Cumulative Hazard function, reversed hazard function, nature of hazard function, class of increasing failure rate distributions, decreasing failure rate distributions, theorems.

UNIT-II: Relations between survival function, probability function, hazard function, cumulative hazard function, reversed hazard function. Elementary idea of lifetime distributions: exponential, weibull, gamma, extreme value distributions, log-normal etc.

UNIT-III: Introduction to Survival Analysis: need of survival analysis: left censoring, right censoring, interval censoring, random censoring, times censoring, order censoring, hybrid censoring. Kaplan-Meier estimator of survival function, properties of Kaplan-Meier estimator, Nelson-Aalen estimator of cumulative hazard function.

Reference Books:

1. Deshpande, J.V. and Purohit, S.G. (2005). Life Time Data: Statistical Models and Methods, World Scientific.
2. Barlow, R.E. and Proschan, F. (1975): Statistical theory of reliability and life testing. Holt, Reinhart and Winston.

SEMESTER III

I. MAJOR COURSE- MJ 4:
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-I: 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). Order Statistics: Introduction, distribution of the rth order statistic, smallest and largest order statistics. Joint distribution of rth and sth order statistics, distribution of sample median and sample range.

UNIT-II: 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-III: 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-IV: 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(n1,n2). 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, 4th 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, 4th Edn. John Wiley and Sons.
5. 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.
6. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor

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II. MAJOR COURSE- MJ 5:
PRACTICALS-II:

Marks: Pr (ESE: 3Hrs) =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 3Hrs 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. Testing of significance and confidence intervals for single proportion and difference of two proportions.
2. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
3. Testing of significance and confidence intervals for difference of two standard deviations.
4. Exact Sample Tests based on Chi-Square Distribution.
5. Testing if the population variance has a specific value and its confidence intervals.
6. Testing of goodness of fit.
7. Testing of independence of attributes.
8. Testing based on 2 X 2 contingency table without and with Yates' corrections.
9. Testing of significance and confidence intervals of an observed sample correlation coefficient.
10. Testing and confidence intervals of equality of two population variances.

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, 4th 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, 4th Edn. John Wiley and Sons.
5. 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.
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

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

A Common Syllabus for FYUGP (Credits: Theory-03) **45 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):
*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, whether Govt. or Private or for future entrepreneurs in the field of IT.

A. INTRODUCTION TO COMPUTER SYSTEM

1. Basic Concept of Computer: What is Computer, Applications of Computer, Types of computer, Components of 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: What is an Operating System, Operating System Examples, 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)**

B. MICROSOFT OFFICE 2016 AND LATEST VERSIONS

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 Work Sheets, 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 Power Point (Presentation Package): Concept and Uses of presentation package, Creating, Opening and Saving Presentations, working in different views in Power point, Animation, slide show, Master Slides, Creating photo album, Rehearse timing and record narration **(5 Hours)**

9. Digital Education: What is digital education, 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 4th Edition, prentice –Hall (2009)
5. Steven Welkler, Office 2016 for beginners, Create Space Independent Publishing Platform (2016)
6. Wallace Wang, Microsoft Office 2019,Wiley (January 2018)
7. Noble Powell, Windows 11 User Guide For Beginners and Seniors, ASIN, (October 2021)

SEMESTER IV

I. MAJOR COURSE- MJ 6:
STATISTICAL INFERENCE

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. 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. Make an inference about the population of interest on the basis of a random sample taken from that population.
5. Hypothesize various advanced statistical techniques for modeling and exploring practical situations.

Course Content:

UNIT-I: Estimation: Problem of estimation, Properties of a good estimator - unbiasedness, consistency, efficiency and sufficiency. 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-II: 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-III:

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-IV: 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. 2nd Edn. (Reprint) John Wiley and Sons.
2. Miller, I. and Miller, M. (2002): John E. Freund's Mathematical Statistics (6th 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. 4th Edition. Marcel Dekker, CRC.

II. MAJOR COURSE- MJ 7:
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-I: 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. 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-II: 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=nxk). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

UNIT-III: 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-IV: 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.

III. MAJOR COURSE- MJ 8:
PRACTICALS-III:

Marks: Pr (ESE: 3Hrs) =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 3Hrs 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. Unbiased estimators (including unbiased but absurd estimators).
2. Consistent estimators, Efficient estimators and relative efficiency of estimators.
3. Cramer-Rao inequality and MVB estimators.
4. Sufficient estimators- Factorization theorem, Rao-Blackwell theorem, Complete sufficient estimators.
5. Lehmann-scheffe Theorem and UMVUE.
6. Maximum Likelihood Estimation.
7. Method of Moment Estimation.
8. Type I and Type II errors.
9. Most Powerful Critical Region (N-P Lemma).
10. Uniformly Most Powerful Critical Region.
11. To select a SRS with and without replacement.
12. Estimation of population mean, Variance, population mean square error in case of with and without replacement for a given sample size.
13. Stratified sampling: allocation of sample to strata by proportional and Neyman's methods and to compare their efficiencies.
14. Estimation of gain in precision in stratified sampling.
15. 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.
16. 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. 2nd Edn. (Reprint) John Wiley and Sons.
2. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th 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. 4th Edition. Marcel Dekker, CRC.
7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.

SEMESTER V

I. MAJOR COURSE- MJ 9:
STATISTICAL QUALITY CONTROL

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 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-I: 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-σ Control charts, Rational Sub-grouping.

UNIT-II: 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. Analysis of patterns on control chart, estimation of process capability.

UNIT-III: Acceptance sampling plan: Principle of acceptance sampling plans. 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-IV: 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. Voice of customers (VOC): Importance and VOC data collection. Critical to Quality (CTQ). Introduction to DMAIC using one case study: Define Phase, Measure Phase, Analyse Phase, Improve Phase and Control Phase.

Reference Books:

1. Montogomery, 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, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.
6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.
7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor

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II. MAJOR COURSE- MJ 10:
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-I: Sequences and their convergence: Sequences, bounded sequence, convergent sequence, monotonic sequence, subsequence, Cauchy's general principle of convergence.

UNIT-II: 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-III: Alternating Series, Leibnitz test, Absolute and conditional convergence. Taylor's theorem, Maclaurin's theorem, remainder after n terms. Power series expansions of:

$\sin x,\ \cos x,\ e^x,\ (1+x)^n,\ \log(1+x)$ using suitable remainder after n terms.

UNIT-IV: Limit, continuity and differentiability, relationship with continuity, Rolle's theorem, Lagrange's and Cauchy's mean value theorems, 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).

III. MAJOR COURSE- MJ 11:
PRACTICALS-IV:

Marks: Pr (ESE: 3Hrs) =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 3Hrs 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. 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. Montogomery, 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. II, 8th 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.

SEMESTER VI

I. MAJOR COURSE- MJ 12:
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
   - direction: positive ($x \uparrow, y \uparrow$), negative ($x \downarrow, y \uparrow$)
   - form: linear or not
   - 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, β_0 is the intercept and β_1 is the slope.
   - Note that the point estimates (estimated from observed data) for β_0 and β_1 are b_0 and b_1, respectively.
7. Define residual (e) as the difference between the observed (y) and predicted ($\hat{y}$) values of the response variable.
   $$e_i = y_i - \hat{y}_i$$
8. Calculate the estimate for the slope (b_1) as
   $$b_1 = r(s_y / s_x)$$
   where, r is the correlation coefficient, sy is the standard deviation of the response variable, and s_x is the standard deviation of the explanatory variable.

Course Content:

UNIT-I: 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-II: 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-III: 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, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.

UNIT-IV: 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, 4th Edition, McGraw Hill Companies.
6. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
7. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan Limited.
8. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley & Sons.

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-I: 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-II: 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-III: 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-IV: 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). 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, 9th 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, 3rd Edition. Prentice Hall of India Pvt. Ltd.
6. Keyfitz N., Beckman John A.: Demogrphy through Problems S-Verlag New York.
7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor

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III. MAJOR COURSE- MJ 14:
LINEAR ALGEBRA

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. 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-I: 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-II: 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-III: 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-IV: 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. 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.

IV. MAJOR COURSE- MJ 15:
PRACTICALS-V:

Marks: Pr (ESE: 3Hrs) =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 3Hrs 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. Estimability when X is a full rank matrix and not a full rank matrix.
2. Distribution of Quadratic forms.
3. Simple Linear Regression.
4. Multiple Regression.
5. Tests for Linear Hypothesis.
6. Bias in regression estimates.
7. Lack of fit.
8. Orthogonal Polynomials.
9. Problem related to General Linear Models.
10. Application problem based on Myre's and UN Indices.
11. Problem based on measures of Mortality.
12. To construct a complete life table.
13. 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. 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. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
6. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, World Press.
7. Ramakumar R.: Technical Demography.
8. Pathak K. B. & Ram F.: Techniques of Demographic Analysis.

SEMESTER VII

I. MAJOR COURSE- MJ 16:
MULTIVARIATE STATISTICAL ANALYSIS AND NON-PARAMETRIC METHODS

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.
8. Testing of hypothesis using Non-Parametric test like Median test, Run test, Kruskal Wallis test etc.

Course Content:

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

UNIT-II: Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions. Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance- covariance matrix. Multiple and partial correlation coefficient and their properties.

UNIT-III: Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis. MANOVA.

UNIT-IV: Non-parametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function. Kolmogrov 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, 3rd 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, 6th 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. 2nd Edn. (Reprint) John Wiley and Sons.

II. MAJOR COURSE- MJ 17:
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-I: 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-II: 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-III: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Assignment problem as a linear programming problem.

UNIT-IV: Rules of network construction, Time calculation in networks, Critical path method, PERT, calculation, advantages of network (PERT/CPM). Game Theory: Formulation and solution of two- person zero-sum 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,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction,* 8th 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.

III. MAJOR COURSE- MJ 18:
STOCHASTIC PROCESSES AND QUEUING 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. 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 Morkov 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-I: Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.

UNIT-II: 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-III: 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-IV: Queuing System: General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity, waiting time distribution (without proof). 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, 3rd Edition, Wiley International.

IV. MAJOR COURSE- MJ 19:
PRACTICALS-VI:

Marks: Pr (ESE: 3Hrs) =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 3Hrs 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. 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. 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
10. Problem based on Markov Chain

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. 4th Edition. Marcel Dekker, CRC.
3. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd 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, 6th Edn., Pearson & Prentice Hall
7. Mukhopadhyay, P.: Mathematical Statistics.
8. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.

SEMESTER VIII

I. MAJOR COURSE- MJ 20:
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-I: 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-II: 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-III: 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-IV: Factorial experiments: advantages, notations and concepts, 2^2, 2^3 and 3^2 factorial experiments, design and analysis, 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, 8th 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.

II. ADVANCED MAJOR COURSE- AMJ 1: ECONOMETRICS

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 econometrics
2. Specification of the model.
3. Multiple Linear Regression.
4. Multicollinearity, Heteroscedasticity and Autocorrelation.

Course Content:

UNIT-I: Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, structural and reduced forms. General linear model (GLM). Estimation under linear restrictions.

UNIT-II: Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, tests and solutions of multicollinearity, specification error.

UNIT-III: Generalized least squares estimation, Aitken estimators. Autocorrelation: concept, consequences of autocorrelated disturbances, detection and solution of autocorrelation.

UNIT-IV: Heteroscedastic disturbances: Concepts and efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Consequences of heteroscedasticity. Tests and solutions of heteroscedasticity. Autoregressive and Lag models, Dummy variables, Qualitative data.

Reference Books:

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
2. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
3. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan Limited.
4. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley & Sons.
5. Madnani GMK: Introduction to Econometrics.

III. ADVANCED MAJOR COURSE- AMJ 2: TIME SERIES 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 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-I: 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-II: Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend.

UNIT-III: Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization. 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-IV: 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, 2nd ed. Revised reprint, Books and Allied.
4. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor

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IV. ADVANCED MAJOR COURSE- AMJ 3:
PRACTICALS-VII:

Marks: Pr (ESE: 3Hrs) =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 3Hrs 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. 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 and2^3 factorial in CRD and RBD
8. Analysis of 2^2 and2^3 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
14. Problem based on Components of Time Series
15. Problem based on Forecasting
16. Orthogonal Polynomials
17. Problem based on Multicollinearity
18. Problem based on Autocorrelation

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, 4th Edition, McGraw Hill Companies.
6. Kendall M.G. (1976): Time Series, Charles Griffin.
7. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied.
8. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor

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COURSES OF STUDY FOR FYUGP IN **"STATISTICS" MINOR**

MINOR COURSE-1A (SEM-I)

I. MINOR COURSE- MN1A: INTRODUCTORY STATISTICS

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

(Credits: Theory-03) **45Hours**

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-I: Introduction: Definition of Statistics, Importance and Scope of Statistics. 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-II: Measures of Dispersion: Common measures of absolute dispersion, Comparisons of different absolute measures, properties of standard deviation, Measures of relative dispersion. Moments, Different types of moments and their relationships, Skewness and Kurtosis: Meaning of Skewness and Kurtosis, different measures of skewness and kurtosis.

UNIT-III: 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, 8th Edn. The World Press, Kolkata.
2. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor.

II. MINOR COURSE- MN 1A PR:
MINOR PRACTICALS-1A PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

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

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs 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. Graphical representation of data.
2. Problems based on measures of central tendency, dispersion, coefficient of variation, moments, skewness and kurtosis.
3. Karl Pearson correlation coefficient.
4. Correlation coefficient for a bivariate frequency distribution.
5. Lines of regression, angle between lines and estimated values of variables.
6. Fitting of polynomials, exponential curves.

Note: Use of Scientific Calculator will be Allowed in Practical Examination.

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. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor.

MINOR COURSE-1B (SEM-III)

III. MINOR COURSE- MN1B: INTRODUCTORY PROBABILITY

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

(Credits: Theory-03) **45Hours**

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-I: Probability: Introduction, random experiments, sample space, events and algebra of events. 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-II: 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. 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-III: 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).

IV. MINOR COURSE- MN 1B PR:
MINOR PRACTICALS-1B PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

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

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs 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. Fitting of binomial distributions for n and p = q = ½.
2. Fitting of binomial distributions for given n and p.
3. Fitting of binomial distributions after computing mean and variance.
4. Fitting of Poisson distributions for given value of lambda.
5. Fitting of Poisson distributions after computing mean.
6. Fitting of suitable distribution.
7. Application problems based on binomial distribution.
8. Application problems based on Poisson distribution.
9. Problems based on area property of normal distribution.
10. To find the ordinate for a given area for normal distribution.
11. Application based problems using normal distribution.
12. Fitting of normal distribution when parameters are given.
13. Fitting of normal distribution when parameters are not given.

Note: Use of Scientific Calculator will be Allowed in Practical 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)

MINOR COURSE-1C (SEM-V)

V. MINOR COURSE- MN 1C:
STATISTICAL INFERENCE AND ANOVA

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

(Credits: Theory-03) **45Hours**

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-I: Estimation: Problem of estimation, Properties of a good estimator - unbiasedness, consistency, efficiency and sufficiency. Factorization theorem (Without proof).

UNIT-II: 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. 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-III: Analysis of variance: one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. 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 Macmillion New York.
7. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
8. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.

VI. MINOR COURSE- MN 1C PR: MINOR PRACTICALS-1C PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

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

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs 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: Use of Scientific Calculator will be Allowed in Practical 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 Macmillion New York.
6. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
7. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.

MINOR COURSE-1D (SEM-VII)

VII. MINOR COURSE- MN1D:
APPLIED STATISTICS

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

(Credits: Theory-03) **45Hours**

Course objectives & Learning Outcomes:

This course will enable the students to:

1. Understand basic theoretical and applied principles of statistics needed to enter the job force.
2. Communicate key statistical concepts to non-statisticians.
3. Solve practical problems in today's data-centric world.
4. Decide what data they need to collect, determine how to collect that data, and then analyze and interpret the data using statistical tools, algorithms, and software.
5. Employ the correct analyses, and effectively present the results.

Course Content:

UNIT-I: Economic Time Series: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and exponential curves). Measurement of seasonal variations by method of simple averages.

UNIT-II: Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts.

UNIT-III: Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates. Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.

Reference Books:

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition(Reprint), Sultan Chand & Sons
4. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
5. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.

VIII. MINOR COURSE- MN 1D PR:
MINOR PRACTICALS-1D PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

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

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs 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 p-chart
3. Problem based on c-chart
4. Problem based on Components of Time Series
5. Problem based on measures of Mortality
6. Problem based on measures of Fertility

Note: Use of Scientific Calculator will be Allowed in Practical Examination.

Reference Books:

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand & Sons
4. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
5. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.
