1. Program Name

Bachelor of Science (Hon's) in Statistics

2. Vision

The vision of the program is to face the challenges and utilize the advantages of statistics under global aspect through building up knowledge and IT based aimed at achieving academic excellence.

3. Mission

The Department of Statistics mission is:

- To produce graduates who have a sound knowledge of the major areas of statistical methodology, founded on rigorous theoretical principles which equip the graduate to acquire further knowledge and skills for the benefit of the country through own study.
- To promote the use and knowledge of Statistics in all fields of Agriculture, Industry, Engineering, Environment, Banking, Social sciences and in which Statistics can contribute to a better understanding of scientific and social phenomena and enhance the quality of decisions and conclusions made on the strength of the statistical approach.
- To contribute to the body of fundamental statistical science through research.

4. Program Objectives

The program is intended to produce high quality graduates who are intellectually and technically competent in building careers in various fields of statistics.

The objectives of the program are to:

- Provide basic understanding of statistical theory and analytical tools that can be used in statistics decision making process.
- Facilitate learners linking statistical theories and practice with a view to solving real life problems and contributing to socio-economic and community development.
- Promote understanding of knowledge of Statistics in all fields of Agriculture, Industry, Engineering, Environment, Banking, Social sciences and in which Statistics can contribute to a better understanding of scientific and social phenomena and enhance the quality of decisions and conclusions made on the strength of the statistical approach.
- Nature a stimulating academic environment through exchange and research collaboration with renowned scholar's professionals.
- Cultivate principles of ethics and social responsibility in the mind set of students.
- Comply with employability needs to meet demands for high quality graduates.

5. Learning Outcomes:

At the end of the program the students will be able to:

- Demonstrate statistical concept, theories, models and data analysis techniques.
- Demonstrate knowledge of probability and the standard statistical distributions.
- Demonstrate knowledge of fixed-sample and large-sample statistical properties of point and interval estimators.
- Demonstrate knowledge of the properties of parametric, semi-parametric and nonparametric testing procedures.
- Demonstrate the ability to perform complex data management and analysis.
- Demonstrate the ability to apply linear, nonlinear and generalized linear models.
- Demonstrate understanding of how to design experiments and surveys for efficiency.
- Demonstrate knowledge of classical and repeated measures multivariate methods and computational techniques.
- Make students engaged in independent learning through involvement in different research and project works.
- Exercise the qualities of scholarly attainment, sense of responsibility and accountability in the familiar, professional and social environment.
- Develop skills to handle independent research and deliver effective presentations.
- Expand the frontier of acquired knowledge through further independent learning and thus add to existing knowledge bank.

6. Course Structure

Serial No.	Course ComponentsCredit	Credit
1	Departmental Core courses	50
2	Courses on Economics	11
3	Courses on Mathematics	17
4	Courses on Public Health and Life Science	12
5	Courses on Environmental Statistics	03
6	Courses on Research Methodology	03
7	Courses on financial and industrial statistics	09
8	Courses on Computer Applications	12
9	Courses on Statistical Lab	24
10	Project Report	03
11	Viva-voce	09
	Total credit requirements for B. Sc. (Hon's) in Statistics	153

7. Teaching- Learning Strategy

Teaching learning strategy refers to the immediate performance of the learners in relation to specific instruction under certain method and level of accuracy. The following teaching method used by the course teacher: Recommended text books including web-based materials, lecture sheet, Class discussion, recitation oral question answer session, case study, presentation each chapter in the course by the student, problem-based learning and solving, Group work, field visit, Individual work, assignment, multimedia projector used for lecture and example cooperative learning, Debate on current issues.

8. Assessment Strategy

Students can also assess their own work in the class, midterm, assignment and their assessment can be a portion of the final grade. This method has educational value as learning to assess one's own progress contributes to the university's goal of preparing our students to be life-long learners.

Evaluation of the student in this course as follows

Process of evaluation	Marks
Class attendance	5%
Assignment and Quiz-test	5%
Term paper presentation	10%
Two mid-term examination (10X2)	20%
Final examination	60%
Total	**100%**

Grading policy of the total 100 marks on the above evaluation process awarded by the semester:

Marks Range	Letter Grade	Grade Point	Interpretation
80+	A+	4.00	Outstanding
75-79	A	3.75	Excellent
70-74	A-	3.50	Very Good
65-69	B+	3.25	Good
60-64	B	3.00	Average
55-59	B-	2.75	Below Average
50-54	C+	2.50	Fair
45-49	C	2.25	Poor
40-44	D	2.00	Minimum Pass
Below 40	F	0	Fail
----------	I	--------	Incomplete
----------	W	--------	Withdrawn

Program Educational Objectives (PEO'S)

PEO-1) Students will have successful academic and research career.

PEO-2) Students will have employment in public and private sectors and resolve economic, social, health and environmental issues.

PEO-3) Students will have to analyze big data and develop different model.

Program Outcomes (PO'S)

Graduates are able to-

PO-1) Provide basic understanding of statistical theory and analytical tools that can be used in statistics decision making process.

PO-2) Facilitate learners linking statistical theories and practice with a view to solving real life problems and contributing to socio-economic and community development.

PO-3) Promote understanding of knowledge of Statistics in all fields of Agriculture, Industry, Engineering, Environment, Banking, Social sciences and in which Statistics can contribute to a better understanding of scientific and social phenomena and enhance the quality of decisions and conclusions made on the strength of the statistical approach.

PO-4) Nature a stimulating academic environment through exchange and research collaboration with renowned scholar's professionals.

PO-5) Cultivate principles of ethics and social responsibility in the mind set of students.

PO-6) Comply with employability needs to meet demands for high quality graduates.

Mapping between PEOs and POs of Statistics program

POs / PEOs	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	2	1		2
PEO2	2	3	3		2	
PEO3	2	2	3	2		

1: Low 2: Significance 3: High

Examination Rules and Regulations for Bachelor's Degree

Admission

As per university rules, students from science discipline is eligible to be admitted into the program. After the announcement of admission test date, intending students should apply through the prescribed application form. A rigorous written test is conducted for the applicants. A combined score is developed based on marks in the written test, SSC and HSC examinations. Selections are made based on the combined score. It should be noted that Bachelor of Science is a terminal degree.

Program Duration and Course Distribution

The duration of B. Sc. program is four years divided into eight semesters. A total of 153 credit hours have to be completed by the students in 40 taught courses, 09 Lab courses, four viva-voce examinations and a project program. Every semester will be of nineteen weeks of which thirteen weeks for class teaching, two weeks break and three weeks for holding the semester final examinations.

For each course unit, there will be three lectures of one hours each in every week and each course unit will be given a weight of 3 credit hours. Students have to appear before viva-voce exams at the end of each class year (i.e., second semester, fourth semester, sixth semester and eighth semester). In addition, students have to undergo a project of three months at the end of eighth semester. The project carries 3 credit hours including the viva-voce. A total of 153 credit hours in the B. Sc. program are distributed as follows:

Class Year	Number of Courses		Total Course Units	Credit Hours
	First Semester	Second Semester		
Course Works				
First Year	06	05	11	32
Second Year	06	05	11	31
Third Year	08	06	13	40
Fourth Year	08	06	14	38
Viva-Voce and Internship/Project Paper				
Viva-Voce				09
Project Report				03
TOTAL				**153**

The B. Sc. program shall be evaluated on the basis of 5100 total marks. Out of which 3850 marks shall be for 40 teaching course units, 900 marks for Statistics Lab, 150 marks for viva-voce examination, and 100 marks for a project report program. The 4-year B. Sc. program has to be completed by maximum of six years from the date of original entry.

Medium of Instruction

The medium of instruction of the program of different academic faculties shall be English and /or Bangla. The Academic Committee of the concerned department shall have the right to decide the medium of instruction.

Examination Entry Requirements

A student will be allowed to take part in Semester Final Examination if s/he fulfills the following conditions:

a. If the student has registered for the concerned semester in due time.

b. If s/he has the required percentage of attendance in each course lecture.

c. If the student has paid all dues (registration fees/tuition fees/other charges) applicable to university administration/residential hall administration/discipline administration.

d. If the student has not been instructed by the Disciplinary Board / Examination Disciplinary Committee to refrain from taking part in the examination.

Evaluation System

a. Theoretical Course: Each theoretical course offered should be composed of either 50 or 100 marks (each 50 marks course consisting of 2 credit point). The proportion of the total marks of a particular course shall be distributed as follows:

Continuous Assessment /Before-Final Assessment	40%
Semester-Final Examination	60%
	Total = 100%

b. Continuous Assessment: Marks allocated for before-final assessment shall be distributed as follows:

i. Internal Evolution:

a)	Mid-Semester examination (At least Two mid-semester exams.)	20%
b)	Class Test and/or Quiz and/or In-course and/or Sudden test and/or tutorial and/or Assignment and /or Term paper preparation & presentation/ Case study and/or practical and/or Field work[1]	15%
	Class Attendance	5%
		Total = 40%

ii. Class Attendance: The marks allocated for class attendance shall be given as following proportions:

Attendance	Marks
90% and above	100%
85% to less than 90%	90%
80% to less than 85%	80%
75% to less than 80%	70%
70% to less than 75%	60%
65% to less than 70%	50%
60% to less than 65%	40%
Less than 60%	00%

iii. Before-final Assessment Report

- At the end of the course, the course teacher shall calculate the total marks of the continuous assessment (including class attendance) and prepare a marks sheet. The answer scripts of the mid-term examinations should be shown to the students as it is valuable for their learning process. The before-final assessment marks have to be submitted to the Controller of the Examinations before the suspension of class for the semester final examinations.
- The course teacher shall also submit the class attendance marks along with the register/documents to the Chairman of the Department. The chairman will take into consideration the attendance mark while forwarding the examination entry forms to the Controller of the Examinations.

c. Class-Attendance Requirements to Appear in the Semester Final Examination

i. If class attendance of any student at any course is below 60%, but in the range of 40% to 59%, s/he will be allowed to attend the examination only with the recommendation of the course teacher and approval of the chairman of the department. In such cases the student will have to pay a fine as fixed by the authority department.

ii. A student with class attendance of less than 40% in any course will be debarred from appearing in the Final Examination.

[1] Concerned department and/or course teacher will decide the allocation of this mark in different activities.

b. Letter Grade and Grade point: Total marks obtained in each course, oral (viva-voce) examination and practical courses shall be converted into LG (Letter Grade) and GP (Grade point) as follows:

Numerical Grade	Letter Grade		Grade point	Interpretation
80% and above	A+	(A Plus)	4.00	Outstanding
75% to less than 80%	A	(A regular)	3.75	Excellent
70% to less than 75%	A-	(A minus)	3.50	Very Good
65% to less than 70%	B+	(B Plus)	3.25	Good
60% to less than 65%	B	(B regular)	3.00	Satisfactory
55% to less than 60%	B-	(B minus)	2.75	Below Satisfactory
50% to less than 55%	C+	(C Plus)	2.50	Average
45% to less than 50%	C	(C regular)	2.25	Pass
40% to less than 45%	D	.....	2.00	Poor
Less than 40%	F	.....	0.00	Fail

* In the Transcript/Grade sheet, only the Letter Grade and the Corresponding Grade points, and final CGPA (in the 8th Semester), not the numerical marks, will be shown.

Promotion[2]

a. For promotion from one semester to the next class tear a student is required to earn minimum CGPA of 2.00 in each class year on condition that s/he has passed the viva-voce.

b. If anybody is absent from the viva-voce on any valid ground a viva-voce may be arranged for him/her on condition that s/he will bear all expenses of the viva. In such case s/he has to apply to chairman of the department within 15 days after the viva-voce exam.

Degree requirements

a. **For Bachelor (Honors) degree/BBA degree, a student requires to**

i. Earn required number of total credit points successfully;
ii. Earn a minimum CGPA of 2.25; and
iii. Complete the program within six academic years from her/his 1st admission to the program.

b. **Award of (Pass) Degree**

i. A student who fails to secure a minimum CGPA of 2.25 after completing eighth semester final examination but succeeds in securing a CGPA between 2.00 and 2.25 will be eligible for a Pass Degree.

Improvement of grades

Only the removal of 'F' (Fail) in any course shall be allowed. Removal of 'F' in any course is permitted sitting in the final examination only for two (2) times in subsequent two semesters excluding the regular examination. In such cases results shall be one grade down (unless the result is a "D" grade) in tabulation and calculation of CGPA.

উপরোক্ত পরীক্ষা বিধির স্থলে ২০১১-২০১২ শিক্ষাবর্ষ থেকে নিম্নোক্ত বিধি কমিটি কর্তৃক সুপারিশ করা হলো- ৩২তম একাডেমিক কাউন্সিল সভার সম্পূরক- ৮ এর সুপারিশ

Improvement of grades

i. A student having earned 'F' grade in any course in any semester shall be required to remove the 'F' grade. Removal of 'F' grade in any course is permitted only for two (2) times excluding the regular examination. This has to be done within his academic tenure.

[2] For the session 2006-07 to 2010-11 the promotion rule is different and is attached in Annex-1.)

ii. A student having earned letter grade 'B-' (GP- 2.75) or below in any course may be allowed to improve the grade by appearing in the semester-final examination with the next available batch . S/he can avail this opportunity only once for a course. In such case the best GPA from the improvement or regular examination/concern subject shall be calculated for tabulation. In such cases results shall be one grade down (unless the result is a 'D' grade) in tabulation calculation of CGPA.

iii. A student having earned 'F' grade in any course in any semester shall be required to remove the 'F' grade. Removal of 'F' grade in any course is permitted only for two (2) times excluding the regular examination. Which has to be done with subsequent available batches.

iv. A student having earned letter grade 'B-' (GP- 2.75) or below in any course may be allowed to improve the grade by appearing in the semester-final examination with the next available batch2. S/he can avail this opportunity only once for a course. In such case the best GPA from the improvement or regular examination/concern subject shall be calculated for tabulation.

v. A student willing to improve grade should apply to the controller of examination through the chairman of the department within 01 (one) week after the publication of the results of the semester.

vi. No improvement shall be allowed in continuous assessment (mid-term/class-test/assignment/ fieldwork/ monograph/ project/ practical/case-study/term-paper/quiz test/etc.).

vii. The concerned (current) examination committee to that semester will take necessary actions to arrange the improvement examinations, tabulation and posting of marks.

* If a student gets one month after his result publication to sit for the examination with a batch that batch will be considered as available batch for her/his.

Re-admission

a. A student failing to earn the requisite credit points for promotion (clause 10) from one semester to the next may seek readmission with the following batch.

b. For readmission a student shall have to apply within one month after the announcement of the result of the concerned semester.

Drop out

a. If a student re-admitted twice in any semester fails to earn minimum required credits[4] for promotion shall be dropped out from the program.

b. If a student fails to earn required total credit points within six academic years since admissions, s/he will be dropped-out from the program and will no more be allowed to continue his/her studentship with other programs.

Credit transfer

No Credit transfer from any other program /University /Institutions to the Comilla University is allowed.

Promotion

a. Promotion will be declared on academic year basis.

b. For promotion from one class year to next class year, a student is required to earn minimum CGPA of 2.00 in each class year. **(২৮ তম একাডেমিক কাউন্সিল সংযোজন on condition that s/he has passed the Viva-voce.)**

Improvement of grades

viii. Student who did not get the opportunity of removing 'F' in any course as per rule 12(i) shall be allowed to sit for a special semester examination. This will be allowed only for the course in 7th and 8th semester. In special cases this opportunity would be allowed for courses in semester 5th and 6th. In such cases student have to apply to the Chairman of the department within one week after publication of the 8th semester result. The Chairman of department shall take necessary administrative measures for arranging the special semester examinations by the respective 4th year examinations committee. All the expenses relating to this examination have to be carried by the candidate(s).

[4] For the session 2006-07 to 2010-11 'the minimum required CGPA in each class year'.

ix. A student having earned letter grade of less than 'B' (less than GP 3.00) in any course may be allowed to improve the grade by appearing in the semester-final examination with the next available batch[5]. S/he can avail this opportunity only once for a course.

x. No improvement will be allowed in 8th semester.

xi. For appearing in the improvement examination, a student shall have to pay fees for the course prescribed for the purpose.

xii. A student willing to improve grade should apply to the controller of examination through the chairman of the department within 01 (one) week after the publication of the results of the semester.

xiii. No improvement shall be allowed in continuous assessment (mid-term/class-test/ assignment/ fieldwork/ monograph/ project/ practical/ case-study/ term-paper/ quiz test/etc.).

xiv. The concerned (current) for that semester will take necessary actions to arrange the improvement examinations, tabulation and posting the marks.

Annex-2 : Rules regarding Examination Offences and Disciplinary Action

Formation of Examination Disciplinary Committee:

1. Disciplinary action against candidates involved in Examination offences shall be taken by the Syndicate on recommendation of the Examination Discipline Committee as constituted below:

(i) The Vice-Chancellor	Chairman
(ii) The Deans of the Faculties	Members
(iii) Two provosts to be nominated by the Vice-Chancellor	Members
(iv) Three teachers of the University to be nominated by the Vice-Chancellor	Members
(v) Two Chairman be nominated by Vice-Chancellor	Members
(vi) Proctor	Member
(vii) The Controller of Examinations	Members-Secretary

2. Members other than Vice-Chancellor members shall hold office for a period of one year after formation of the committee.

3. Five members shall form the quorum

4. The following shall be considered Examination offences:

   (a) Communication or attempt to communicate with any other candidate in the Examination Hall.

   (b) Writing in the Examination Hall anything incriminating on the question paper or admit card, table, desk, bench, etc.

   (c) Possession of incriminating notes, books, map, chart, slip, chit or any other documents, in the examination hall.

   (d) Creating or inciting to create any nuisance or disturbance in the Examination Hall.

   (e) Copying or attempt to copy from incriminating documents or from another's script, or from any writing on the person or wearing apparel while appearing at the Examination.

   (f) Taking the script out of the Examination Hall.

   (g) Changing the script or inserting unauthorized sheets in the script.

   (h) Approaching or influencing the Invigilator, Examiners, or members of the Examination Committee, Tabulators to gain undue favor or advantage in connection with Examination.

   (i) Using abusive language or holding out threat to the invigilator or any other person engaged on Examination duty inside or outside the Examination Hall.

   (j) Assault or attempt to assault or use criminal force against Chief Invigilator or the Invigilator or any other person engaged on Examination duty inside or outside the Examination Hall.

[5] If a student gets one month after his result publication to sit for the examination with a batch that batch will be considered as available batch for her/his.

5. In making its recommendation, the Examination Discipline Committee shall follow the following rules.

   (a) Candidates found guilty of offence or offences falling under Section 4 (a), (b) and (c) shall be penalized with the cancellation of the Examination at which they commit offence or offences.

   (b) Candidates found guilty of offence falling under Section 4(d) shall in addition to cancellation of the Examination at which the offence is committed, be debarred from appearing at the subsequent Examination.

   (c) Candidates found guilty of offences falling under Section 4(e), (f), (g) and (h) shall, in addition to the cancellation of the Examination at which the offence is committed, be debarred from appearing at two or three subsequent Examinations or from that semester depending on the gravity of the offence.

   (d) Candidates found guilty of offence falling under Section 4 (i) and (j) shall, in addition to the cancellation of the Examination at which the offence is committed, be debarred from appearing at the subsequent Examinations of the one or two semesters depending on the gravity of the offence.

6. Any other offence not covered by the above rules shall be dealt with by the Syndicate on the recommendation of the Examination Discipline Committee as it deems fit.

7. Candidates committing offences except those falling under Section 4 (a), (b), (c), (d), (e) and (i) shall not be allowed to continue to appear in that paper, and their scripts shall not be sent for evaluation but shall be sent separately to the Controller of Examinations in sealed cover.

8. The Invigilator shall submit separate report for each case, regarding the nature of the offence and the circumstances in which it is alleged to have been committed, with all supporting documents underlining the coped portion in the script as well as in the incriminating documents in the case of actual copying.

9. The Chief Invigilator of the Examination Center shall forward the report of the Invigilators and relevant documents with his expressed opinion along with the script. These reports and documents will be preserved by the Controller of Examinations for a period of at least six months from the date of the publication of the penalty list.

10. The following procedure shall be adopted in dealing with cases of candidates involved in Examination offences:

    (i) On receipt of reports from the Chief Invigilator of the Examination Center, the Controller of Examinations shall call for explanation from the candidate concerned asking him why disciplinary action shall not be taken against him for the alleged committed of examination offence. Such show-cause notice must be sent by registered post to his permanent address as recorded in the Examination Entry Form registration form. The candidate must be given ten days' time from the date of issue of show-cause notice to submit his explanation. If no explanation is received within the prescribed time limit, the Examination Disciplinary Committee may take necessary disciplinary action.

    (ii) The controller of Examinations will then place all relevant documents of the case together with the explanation of the candidate to the Examination Discipline Committee for consideration. The proceedings of the Discipline Committee shall be forwarded to the registrar for reporting it before the Syndicate.

11. Provided that in any emergency, notwithstanding the provisions of the Rules and Regulations on the subject, the Vice-Chancellor may in exercise of the powers vested in him in terms of clause (j) of Section 11 [of the Comilla University Act, 2006; take any disciplinary action considered necessary in the circumstances and report the same to the Syndicate for information.

Annex-5: Computation of Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

The GPA and CGPA will be computed in following formula:

$$GPA = \frac{\Sigma (\text{Credit} \times \text{Grade Points Secured})}{\text{Total Credits Offered in the Semester}^{6}}$$

$$CGPA = \frac{\Sigma (\text{Credit} \times \text{Grade Points Secured})}{\text{Total Number of Credits offered in the whole program}}$$

[6] For Session 2006-07 to 2010-11 'Total Credits offered in the Year'.

Dean's Honor list, Dean's Merit list and Honor Society

Students who have earned GPA of 4.00 in any semester shall be included in the Dean's Merit list of the semester. Students securing a CGPA of at least 3.90 shall be included in the Dean's Honor list of the year.

Calculation of Cumulative Grade Point Average (CGPA)

Example:

First Year First Semester

Course	(1)	(2)	(3)	(4) = (1) x (3)
	No. of Credits	Grade Awarded	Total Grade Points	Grade Points Secured
Stat-111	3	B	3.00	9.00
Stat-112	3	A+	4.00	12.00
Stat-113	3	D	2.00	6.00
Stat-114	3	A	3.75	11.25
Stat-115	3	A-	3.50	10.50
Stat-116	3	A	3.75	11.25
Total	**18**			**60.00**

SGPA = Total Grade Points Secured ÷ Total Number of Credits = 60.00 ÷ 18 = 3.33

First Year Second Semester

Course	(1)	(2)	(3)	(4) = (1) x (3)
	No. of Credits	Grade Awarded	Total Grade Points	Grade Points Secured
Stat-121	3	B	3.00	9.00
Stat-122	3	C+	2.50	7.50
Stat-123	3	D	2.00	6.00
Stat-124	3	A	3.75	11.25
Stat-125	3	A+	4.00	12.00
Viva-voce	2	A	3.75	7.50
Total	**17**			**53.25**

SGPA = Total Grade Points Secured ÷ Total Number of Credits = 53.25 ÷ 17 = 3.13

Cumulative Data:

Total Credit = (18+ 17) = 35

Total Grade Points Secured = (60.00+ 53.25) = 113.25

Cumulative Grade Point Average (CGPA) = 113.25 ÷ 35 = 3.24

Department of Statistics

Comilla University

Curriculum of B. Sc. (Hon's)

Academic Session: 2018-2019, 2019-2020, and 2020-2021

Particulars	Credits
Courses – 40 Courses	117
Statistics Lab	24
Viva-Voce	09
Project	03
Total	**153**

Department of Statistics
Comilla University
Curriculum of B. Sc. (Hon's)
Academic Session: 2018-2019, 2019-2020, and 2020-2021

Year & Semester	Course Code	Course Title	Credit No.
B. Sc First Year First Semester	Stat-111	Elements of Statistics	3
	Stat-112	Elementary Probability	3
	Stat-113	Linear Algebra	3
	Stat-114	Calculus	3
	Stat-115	Microeconomics	3
	Stat-116	Statistical Data Analysis-I	2
B. Sc First Year Second Semester	Stat-121	Introductory Bivariate Statistics	3
	Stat-122	Probability Distribution	3
	Stat-123	Algebra and Analytical Geometry	3
	Stat-124	Macroeconomics	3
	Stat-125	Programming with C	3
		Viva-voce	2
B. Sc Second Year First Semester	Stat-211	Sampling Distribution	3
	Stat-212	Sampling Technique-I	3
	Stat-213	Numerical Analysis	2
	Stat-214	Statistical Quality Control and Index Number	3
	Stat-215	Advanced Calculus and Differential Equations	3
	Stat-216	Statistical Data Analysis- II	3
B. Sc Second Year Second Semester	Stat-221	Statistical Inference-I	3
	Stat-222	Regression Analysis	3
	Stat-223	Real Analysis	3
	Stat-224	SPSS, STATA and SAS	3
	Stat-225	Statistical Data Analysis-III	2
		Viva-voce	2
B. Sc Third Year First Semester	Stat-311	Stochastic Process	3
	Stat-312	Design of Experiment-I	3
	Stat-313	Introductory Demography	3
	Stat-314	Time Series Analysis	3
	Stat-315	Econometrics-I	3
	Stat-316	R and Python	3
	Stat-317	Statistical Data Analysis- IV	2
	Stat-318	Statistical Data Analysis- V	2
B. Sc Third Year Second Semester	Stat-321	Statistical Inference-II	3
	Stat-322	Order Statistics and Non-Parametric Methods	3
	Stat-323	Linear Programming and Operation Research	3
	Stat-324	Environmental Statistics	3
	Stat-325	Research Methodology	3
	Stat-326	Statistical Data Analysis- VI	3
		Viva-voce	2
B. Sc Fourth Year First Semester	Stat-411	Multivariate Analysis	3
	Stat-412	Sampling Techniques-II	3
	Stat-413	Mathematical Demography	3
	Stat-414	Statistical Simulation	2
	Stat-415	Epidemiology	3
	Stat-416	Actuarial Statistics	3
	Stat-417	Statistical Data Analysis-VII	3
	Stat-418	Statistical Data Analysis-VIII	3
B. Sc Fourth Year Second Semester	Stat-421	Design of Experiment-II	3
	Stat-422	Biostatistics	3
	Stat-423	Econometrics-II	2
	Stat-424	Data Mining	3
	Stat-425	Statistical Data Analysis- IX	2
	Stat-426	Statistical Data Analysis- X	2
	Stat-427	Project Report	3
		Viva-voce	3

This course structure was approved in the meeting of the Committee of Courses of the Department, held on 4thJuly, 2018 and Faculty Executive Committee, held on.... This course structure was approved and passed in the meeting of the Academic Council of the University on.....

Detailed Curriculum

First Year
First Semester

Course Title: Elements of Statistics

Course Code	Stat-111	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The course is designed to make the beginners oriented with the basic statistics tools to be used in courses at advanced level.

Objectives

The aim of this course is to:

- Orient students with the history and scope of statistics.
- Help them to know types of data and how to collect data.
- Make the students to organize the data by graphical and in tabular form.
- Develop basic skills about measures of locations.
- Make the students to compare different data set and measures of dispersion.
- Develop skills to analyze moments and shape of characteristics of distribution.

Learning Outcomes

At the end of the course students will be able to-

- Gather basic knowledge regarding concepts used in statistics and the theories developed through using these concepts.
- Gather knowledge about different types of data and the collection of data.
- Demonstrate basic knowledge about measure of locations.
- Understand and analyze the variability of the data.
- Understand the moments and shape characteristics of distribution.

Course Contents

History and Scope: History, Definition, Nature, Scope and Classification of Statistics, Limitation, Uses and Abuses of Statistics.

Data and Data Collection: Population, Sample, Variables and Attributes, Types of Variables, Scales of Measurement: Nominal, Ordinal, Interval and Ratio; Primary and Secondary Data, Methods of Collecting Data.

Organization of Data: Classification and Tabulation of Data, Frequency Distribution, Graphical Presentation of Data, Stem and Leaf Display, Dot Plot, Time Series Plot.

Measures of central Tendency: Mean, Median, Mode, Geometric Mean, Harmonic Mean, Quintiles with their Graphical Presentation, Application of Different Measures of Central Tendency, Five Number Summary.

Measures of Dispersion: Absolute Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Variance and Standard Deviation. Relative Measures of Dispersion: Coefficient of Range, Coefficient of Quartile deviation, Coefficient of Mean Deviation and Coefficient of Variation. Box Plots and their Uses, Application of Different Measures of Dispersion.

Moments and Shape Characteristics of Distribution: Moments, Sheppard's Corrections for Grouping Error, Skewness and Kurtosis.

Text Book

1. Allan G. Bluman, (2013): *Elementary Statistics: A Step By Step Approach*, 9th Edition. McGraw Hill Inc

Reference Books

1. Lind, A. D., Marchal, W. and Wathen, S. (2014): *Statistical Techniques in Business and Economics*, 16th Edition, Mcgraw Hill Inc.
2. Yule, G.U. and Kendall, M.G. (1999): *An Introduction to the Theory of Statistics*, Universal Book Stall, New Delhi.
3. Islam, M. N (2004): *An Introduction to Statistics and Probability*, 3rd edition, Mullic & Brothers.

Course Title: Elementary Probability

Course Code	Stat-112	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Statistical methods are largely dependent on the theory of probability. Before knowing statistical decision procedures one must have to know about the theory of probability. The concept of probability is applied to all scientific investigation and everyday life.

Objectives

The aim of this course is to:

- Familiarize him/herself with different approaches to probability theory
- Gather knowledge about Venn diagram to represents the results of set operations.
- Understand the basic principles of probability including the laws for unions, intersections, and complementation, Bayes theorem and use these principles in problem solving situations.
- Understand discrete, continuous and joint random variables and compute the mean variance and covariance of a random variables
- Gather knowledge about probability density, distribution function and joint density function of the random variables
- Understand limit theorems, such as central limit theorems.
- Know different generating function, like as- Moment Generating Function, Characteristics function etc..

Learning Outcomes

At the end of the course students should be able to-

- Use Venn diagram to represents the results of set operations
- Compute probabilities and conditional probabilities in appropriate ways.
- Use the ideas of conditional probability and independence and Bayes theorem to compute the probability of an event.
- Compute the probabilities of events, expectations and the covariance's and correlations between any two random variables from the given joint pf/pdf of several random variable
- Recognize the importance of the central limit theorem and understand when it is appropriate to use normal approximations for the distribution of a statistic.
- Find the generating function (e.g. mgf, cf) from a distribution

Course Contents

Set Theory: Set, point of a set, describing set- List method and Roster method, finite set, infinite set, universal set, empty set and subsets. Set operations.

Basic Concepts of Probability: Approaches to defining Probability: Subjective and Objective Probabilities, Classical, Empirical, Geometric and Axiomatic, Experiment, Outcomes, Equally likely outcomes, Mutually exclusive outcomes, Favorable outcomes, Exhaustive outcomes, Random experiment, Sample space and events, Event space, Union and Intersection of Events, Different Types of Events, Odds and Odds Ratio, Function, Set Function, Probability Functions, Theorems on Probability, Probability Space, Total Probability, Tree Diagrams and Compound Probability, Conditional Probability, Baye's Theorem and its application.

Random Variable: Concepts of Random Variable, Discrete and Continuous Variables, Functions of Random Variables. Probability Mass Function, Probability Density Function, Distribution Function and their Properties.

Expectation: Meaning of Expectation, Mean, Variance, Moments, Expectation of Sums and Products Random Variables, Chebyshev's Inequality, Markov Inequality, Central Limit Theorem.

Generating Function: Moment Generating Function, Factorial Function, Characteristic Function, and Probability Generating Function, Cumulant Generating Function and Their Properties, Inversion Theorem.

Joint and Conditional Distribution: Joint Distribution Functions, Marginal Distribution and Conditional Distributions, Independence of Random Variables, Conditional Mean and Conditional Variance, Covariance and Correlation Coefficient, Cauchy-Schwarz Inequality

Text Book

1. Ross, S. (2014): *A First Course in Probability*, 9th Edition, Pearson Education Inc.

Supplementary

1. Feller, W. (1985): *Introduction to Probability Theory and Its Applications*, Vol.1, 3rd edition, John Wiley & Sons, New York.
2. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics*, 3rd edition, McGraw-Hill.

Course Title: Linear Algebra

Course Code	Stat-113	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The course is designed to an essential part of the curriculum of majors such as: Computer science, Engineering, Economics, Physics, and Mathematics. It is blends computational and conceptual aspects of mathematics.

Objectives

The aim of this course is to:

- Examine key ideas in linear algebra.
- Improve and develop their analytical thinking skills and their ability to communicate technical arguments clearly.
- Understand material on vector spaces and related topics.
- Introduce more advanced work in this area including applications to geometry, data fitting and differential equations.
- Motivated by the geometry of problems in two and three dimensions.
- The algorithms of linear algebra are also central to the theory of scientific computing and numerical analysis.

Learning Outcomes

At the end of the course students should be able to-

- Fluent in row reducing matrices and will acquire the Jordan Gauss elimination algorithm for Solving linear systems.
- Solve problems from a variety of areas inside and outside Mathematics using system of linear equations.
- Derive linear relations between column-vectors of a matrix from its row reduced echelon form.
- Compute inverse matrices and determinants using row reduction.
- Prove most of matrix algebra formulas and the main theorems of the course.
- Compute eigenvalues and determinants.
- Learn about vector space as a unifying concept for understanding properties of vectors, Polynomials and matrices.
- Learn diagonalization problem with some applications.

Course Contents

Vectors: Addition and Scalar Multiplication. Vector Product. Geometrical Interpretation of Vector. Linear Dependence and Independence. Vector Space. Basis and Dimension. Sub space. Cauchy-Schwarz Inequality, Triangle Inequality, Linear Transformations, Properties of Linear Transformations.

Matrices: Definition of Matrix, Basic Operations and their Properties, Different Types of Matrices: Square, Identity, Scalar, Diagonal, Null, Symmetric, Skew-symmetric, Orthogonal, Unitary, Hermitian, Skew-Hermitian, Idempotent, Nilpotent and Involuntary, Random, Variance-covariance and Correlation, Product, Kronecker Products, Partitioned Matrices, Matrix Products as Linear Combinations, Transpose of Matrix, Trace of Matrix and its applications in Statistics.

Determinant: Meaning Properties of Determinant, Determinant by Cofactor Expansion, Minors, Cofactors, Ad joint, Combinatorial Approach to Determinant, Evaluating Determinant by Row Reduction.

Rank and Inverse Matrix: Rank and Elementary Transformations of Matrices, Related Theorems of Ranks, Diagonal Reduction of Matrix, ad joint, Inverse, Generalized Inverse of Matrix, Properties of Inverse, Matrix Inequalities and Maximization, Canonical and Normal form of Matrix, Linear Function of Matrices, Integration of Matrices, Elementary matrices.

Eigenvalues and Eigenvectors: Definition of Eigenvalues and Eigenvectors, Diagonalization, Orthogonal Diagonalization.

Characteristic Value Problem and Quadratic Form: Characteristic Value Problem, Similarity, Characteristic Roots and Vectors of Matrix, Theorems of Characteristic Roots and Vectors: Caley-Hemilton Theorem, Finding Square Root of Square Matrix, System of Linear Equation, Spectral Decomposition, Solving Linear System by Factorization, Classification and Identification of Quadratic Forms, Diagonalization of Quadratic Forms, Reduction of Quadratic Forms, Related Theorems, Derivatives of Quadratic Form with Respect to Vector.

Text Book

1. Anton, H. and Rorres, C. (2014): *Elementary Linear Algebra*, 9th edition, John Wiley and Sons, New York.

Reference Books

1. Aitken, A.C. (1982): *Determinant and Matrices*, Oliver and Boyd, London.
2. Hadley, G. (1993): *Linear Algebra*, 6th rep., Narosa, New Delhi.
3. Narayan, S. (1985): *A Texbook of Matrices*, 8th edition, Sultan Chand and Co., New Delhi.

Course Title: Calculus

Course Code	Stat-114	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The main task of this course is to make student understand about basic knowledge of calculus as well as practical implementation of calculus. Another vision is to make student understand the link or relationship between statistics and calculus.

Objectives

Objectives of this course are to-

- Understand the major problems of differential and integral calculus.
- Understand the importance of linear functions in mathematics.
- Understand and recognize other important classes of functions (such as trig and rational functions), and be able to use calculus fluidly with these functions.
- Solve important practical problems in an optimal way.

Learning Outcomes

After completing this course a student will able to-

- To understand insight about function and different types of function.
- Find the limit of a function using the Limit Laws.
- Find infinite limits and limits at infinity.
- Use limits to determine vertical and horizontal asymptotes of the graph of a function.
- Use the definition of continuity to determine if a function is continuous.
- Find the derivative of elementary algebraic functions and trigonometric functions using the definition of derivative, implicit differentiation and differentiation formulas.
- Find linear approximations and differentials of functions and use them to solve application problems.
- Learn to use derivatives for graphing algebraic and trigonometric functions and to solve optimization problems.
- Find intervals of increase and decrease and local extreme values of elementary algebraic functions and trigonometric functions.

Course Contents

Functions: Function and Relation, Domain, Range, Inverse Function and Graphs of Functions Like exponential, Logarithmic, Sine, Tangent etc., Limits, Existence and Finding of Limits, Sandwich Theorem, Limit Involving Infinity, Intermediate Value Theorem, Continuity, and Indeterminate Form.

Ordinary Differentiation: Differentiability, Differentiation, Successive Differentiation and Leibnitz Theorem, Application of the Derivative, Extreme Value Theorem.

Expansions of Functions: Rolle's Theorem, Mean Value Theorem, Residue Theorem, First Derivative Test, Concavity Test, Second Derivative Test, Taylor's and McLaurin's Formulae, Maxima and Minima Functions of One Variable.

Partial Differentiation: Euler's Theorem, Tangents and Normal Asymptotes, L-Hospitals Rule, Guide Line for Sketching Graph.

Indefinite and Definite Integrals: Method of Substitution, Integration by Parts, Special Trigonometric Functions and Rational Fractions. Fundamental Theorem of Definite Integrals, General Properties, Evaluations of Definite Integrals and Reduction Formulae, Ideas of Double Integral and Triple Integral, Finding the Area of Region, Finding the Value of a Solid Revolution, Riemann Theorem/Sum, Derivation of Inverse Function, Integration by Parts.

Text Book

1. Anton, H (2006): *Calculus with Analytic Geometry,* Wiley, New York.

Reference Books

1 Ayres, F. and Meldelson, E. (1992): *Calculus*, McGraw Hill, 3rd edition, New York.

2 Bacon, H.M. (1942): *Differential and Integral Calculus*, 2nd edition, McGraw-Hill, New York.

3 Das, B. C., and Mukharjee, B. N. (2009-2010): *Integral Calculus*, Revised edition, U. N. Dhur& Sons Private Ltd.

4 Das, B. C., and Mukharjee, B. N. (2010-2011): *Differential Calculus*, Revised edition, U. N. Dhur& Sons Private Ltd.

5 Edwards, J. (1994): *Differential Calculus*, Macmillan, London

6 Lang, S. (1988): First *Course in Calculus,* 5th edition, Springer-Verlag, New York.

Course Title: Microeconomics

Course Code	Stat-115	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Microeconomics focuses on the process used by economic agents to maximize satisfaction (or profits) they receive from participating in economic activities.

Objectives

Objectives of this course is to-

- Introduce students to the basic concepts, terminology, methodology and theory used by economists to describe the workings of market based economies
- Perform supply and demand analysis to analyze the impact of economic events on markets and relate how supply and demand interact to determine market equilibrium.
- Discuss price elasticity of demand and supply and how it can be applied.
- Give the names and summarize the main characteristics of the four basic market models and list the conditions required for purely competitive markets
- Distinguish between the short run and the long run in pure competition and explain the long run equilibrium position for a competitive firm
- Explain how a pure monopoly sets its profit-maximizing output and price.
- Explain why monopolistic competitors earn only a normal profit in the long run

Learning Outcomes

Upon successful completion of the course, students will be able to:

- Explain the determinants of demand and supply
- Explain the price elasticity of demand and price elasticity of supply, and compute both using the midpoint method
- Graphically illustrate market equilibrium, surplus and shortage
- Differentiate between marginal utility and total utility and explain how consumers maximize total utility within a given income using the Utility Maximizing Rule
- Describe the various types of markets and compare their efficiency
- Distinguish between perfect competition and imperfect competition and be able to explain the welfare loss in non-competitive markets.

Course Contents

Scope and Methods of Economics: Meaning of Economics. Scarcity, Choice, Tradeoff and Efficiency, Production Possibility Frontier, Major Economic Problems.

Demand, Supply and Price: Determinants of Demand and Supply, Laws of Demand and Supply, Movements along and Shift of Demand and Supply Curves, Equilibrium Price and Quantity, Concept of Elasticity of Demand and Supply

Utility and Preferences (Indifference Curve):

Utility: Concept of Utility, Cardinal and Ordinal Utility, Law of Diminishing Marginal Utility, Principle of Equi-Marginal Utility per Unit of Money Spent, Paradox of Thrift.

Indifference Curve: Indifference Curve and its Characteristics, Budget Line, Substitution Effect, Income Effect and Price Effect.

Cost-Output Relationship: Concept of Short-run and Long-run, Average, Marginal and Total Product, Relationship between AP and MP, Law of Diminishing Marginal Returns, Variable Cost, Fixed Cost and Total Cost, Returns to Scale, Relationship between AC and MC.

Perfect Competition Market: Features of Perfect Competition Market, Marginal Analysis of a Firm, Short-run and Long-run Supply Curve of a Firm, Profit Outcomes in the Short-run and Long-run, Breakeven and Shutdown Point, Efficiency of Competition.

Imperfect Competition Market: Features of Monopoly, Monopolistic Competition, and Oligopoly, Price Settings Strategies of Monopoly, Price Discrimination and its Types, Monopoly's Output and Price, Dead Weight Loss.

Text Book

1. Parkin, M (2003): *Microeconomics,* 6th edition, Pearson Education Inc., Australia.

Reference Books

1. Mankiw, N. G (2001): *Principles of Microeconomics,* Latest edition, Worth Publication.
2. Samuelson, P. A. and Nordhaus, W. D. (2001): *Economics,* 17th edition, McGraw-Hill, New York.

Course Title: Title: Statistical Data Analysis-I

Course Code	Stat-116	Course Credit	02	Number of Class	20-26	Full Marks	50

Group A(Elementary Statistics): 35 Marks

Rationale

This course aims to provide insight into basic statistical concepts with emphasis on practical applications by using EXCEL.

Objectives

The aim of this course is to-

- Know the steps of construction of frequency distribution with equal and unequal class
- Organize and summarize data and represent graphically the important information contained in a data set.
- Compute numerical quantities that measure the central tendency and dispersion of a set of data.
- Improve abilities to analyze moments and shape of characteristics of distribution

Learning Outcomes

After studying all materials and resources presented in the course, the student will be able to-

- Construct frequency distribution for equal and unequal class.
- Use appropriate graph for a particular data set and then interpret the graph
- Find different measures of central tendency and dispersion of a set of data and they will also be able to interpret the results in a proper way.
- Construct tables and graphs that display measures of central tendency.
- Determine the shape characteristics of a distribution and interpret the result

Course Contents

Construction of Tables and Frequency Distributions with Equal and Unequal Class Intervals, Graphical Representation of data, Calculation of Statistical Averages, Quartiles. Calculation of Various Measures of Dispersion- Range, Inter-quartile Range, Quartile Deviation, Mean Deviation, Variance, Standard Deviation, Standard Error, Coefficient of Variation etc. Moments, Skewness and Kurtosis.

Text Book

1. Allan G. Bluman, (2013): Elementary Statistics: A Step By Step Approach, 9th Edition. Mcgraw Hill Inc
2. Stuart, A. and Ord, J. K. (1994): *Kendall's Advanced Theory of Statistics, Vol 1: Distribution Theory,* 6th edition, A Hodder Arnold Publication.

Group-B (Linear Algebra): 15 Marks

Rationale

This course provides grounding on vectors, matrices, and solving systems oflinear equations that is fundamental for future mathematics courses and also many practical applications by using EXCEL.

Objective

The objectives of this course is to:

- Work with matrices and determine if a given square matrix is invertible.
- solve systems of linear equations, compute determinants and know their properties
- find Eigen values and eigenvectors of a matrix

Learning Outcomes

Students that successfully complete this course will be able to-

- Carry out matrix operations, including inverses and determinant
- Write a system of linear equations as a matrix equation and interpret the meaning of the solution set of a system of linear equations.
- Solve systems of linear equations by using Gaussian elimination to reduce the augmented matrix to row echelon form or to reduced row echelon form.
- Find the characteristic equation, eigenvalues and corresponding eigenvectors of a given matrix.
- Compute the inner product of two vectors.

Course Contents

Matrix Inversion, Rank of Matrix, Vector Space, Solution of Homogeneous and Non-Homogeneous System of Equations, Eigenvalues and Eigenvectors , Calculation of Latin Roots, Indices of Matrices of Different Quadratic Forms.

Text Book

Anton, H. and Rorres, C. (2005): *Elementary Linear Algebra,* 9th edition, John Wiley and Sons, New York.

First Year
Second Semester

Course Title: Introductory Bivariate Statistics

Course Code	Stat-121	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Introductory Bivariate Statistics is a basic tool of analysis, and one must be familiar with statistical concepts in order to understand analytical efforts. This Course is designed to provide a solid foundation in statistics.

Objectives

The objectives of this course is to-

- Foster the learner's theoretic and practical understanding of bivariate data and construction of bivariate table.
- Give the beginner a clear sense of how to investigate the strength and direction of a relationship between two variables by collecting measurements and using appropriate statistical analysis.
- Evaluate and interpret the outcomes of correlation matrix, i.e. correlation coefficients, strength, direction and significance level.
- Understand the concept of regression model and able to interpret the effect of variables regression coefficients (ß, Beta), coefficient of determination (R^2), ANOVA table, F- test and T- test.
- Investigate the basic ideas of analysis of attributes, Measures of association and construction of contingency table.
- Give the students preliminary ideas about hypothesis testing.

Learning Outcomes

Students who successfully complete the course should able to-

- Understand the meaning of bivariate data and can distinguish bivariate data from single variable (univariate) data.
- Create and interpret scatter plots to investigate and comment on relationships between two numerical variables.
- Find and interpret the sample correlation coefficient (r) to determine the strength and direction of the linear relationship between predictor and response variables.
- Understand the concept of regression and be able to make prediction
- Become familiar with categorical data and analysis of attributes

Course Contents

Correlation: Concept of Bivariate Data, Scatter diagram, Construction of Bivariate Table. Simple Correlation, Correlation Ratio, Rank Correlation, Spearman Rank Correlation, Kendall's Tau, Intra-class Correlation, Serial and bi-serial Correlation, Partial and Multiple Correlation, Spurious Correlation and Non-sense Correlation.

Simple Linear Regression: Simple Linear Regression Model, Model Assumptions, Method of Least Square, Minimum Perpendicular Method, Properties of the Least Square Estimators and Fitted Regression Model, Prediction, Coefficient of Determination, Lack of Fit and Pure Error, Inverse Linear Regression, Confidence Interval,

Analysis of Attributes: Basic Ideas, Classification, Order of Classes and Class Frequencies, Ultimate Class Frequencies, Positive Attributes, Consistency, Incomplete Data, Association of Attributes, Independence, Complete Association and Disassociation, Measures of Association, Coefficient of Association, Coefficient of Colligation and Partial Association. Contingency Table, Analysis of r x c Contingency Table, Analysis of 2x2 Contingency Table by Yate's Correction, Fisher's Exact Test, Power Function of 2×2 Contingency Table.

Text Book

1. Draper, N.R. and Smith, H. (1998): *Applied Regression Analysis*, 3rd edition, John Wiley and Sons, New York.

Reference Books

1. Lind, A. D., Marchal, W. and Wathen, S. (2014): *Statistical Techniques in Business and Economics*, 16th Edition, McGraw Hill Inc.
2. Stuart, A. and Ord, J. K. (1994): *Kendall's Advanced Theory of Statistics*, Vol 1: Distribution Theory, 6th edition, A Hodder Arnold Publication.
3. Gupta, S.P. and Kapoor, V. K. (2009): *Fundamentals of Mathematical Statistics*, 11th edition, Sultan Chand &Son.
4. Montgomery, D.C. and Peek, E, (1992): *An Introduction to Regression Analysis*, 2nd edition, John Wiley and Sons, New York.

Course Title: Probability Distribution

Course Code	Stat-122	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course offers Statistics Majors with the basics of Probability Distributions (both discrete and continuous). And obviously by understanding the essential dimension of probability distribution as a course, disseminating knowledge of it and fostering students to prepare them as dexterous resources in the arena of scientific research.

Objectives

The main objectives of this course is to -

- Provide students with essential tools in probability theory to understand the theory of statistics and their applications,
- Introduce and study the properties of univariate discrete and continuous probability distributions
- Introduce and study the properties of bi-variate continuous probability distribution such as-bivariate normal distribution
- Compute probabilities for various discrete and continuous probability distributions

Learning Outcomes

After completing the study of the discipline Probability distribution the student should:

- Know the main tools to describe a random variable, such as the probability density function, the cumulative distribution function,
- Know the most widely used discrete probability distributions such as Bernoulli, Binomial, Poisson, Uniform, Multinomial, Truncated Binomial and Poisson and recognize them in applications.
- Know the most widely used continuous probability distributions such as Uniform, Normal, Exponential, Gamma, Beta, Log Normal, Pareto, Laplace Double Exponential, Cauchy, Weibull, Gumbel and recognize them in applications.
- Adroit to use probability generating function, moment generating function, cumulant generating function and characteristic function, derive them in simple cases, and use them to evaluate moments in case of univariate discrete and continuous probability distributions.
- Explain the concepts of bivariate distribution, and how to apply them.

Course Contents

Introduction: Concept of Probability Distribution, Distribution Function, Mass Function, Density Function,

Univariate Discrete Distribution: Bernoulli, Binomial, Poisson, Hyper Geometric, Geometric, Negative Binomial, Uniform or Rectangular, Multinomial, Truncated Binomial and Poisson.

Univariate Continuous Distribution: Uniform, Normal, Exponential, Gamma, Beta, Log Normal, Pareto, Laplace Double Exponential, Cauchy, Weibull, Gumbel and other Exponential Family of Distributions, Triangular.

Bivariate Distributions: Bivariate Probability Distribution, Bivariate Normal Distribution and its Properties.

1. Hogg, R.V. and Craig, A. T (2009): *Introduction to Mathematical Statistics,* 6th edition, Pearson Education, Singapore.
2. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics,* 3rd edition, McGraw-Hill, New York.
3. Kendall, M. and Stuart, A. (1979): *The Advanced Theory of Statistics,* Volume 2, 4th edition, Macmillan Publishing Inc., New York.

Reference Books

1. Johnson, N., Kotz, S. and Kemp, A. (2008): *Univariate Discrete Distributions,* 3rd Edition, John Wiley and Sons, New York.
2. Johnson, N. and Balakrishnan, N. (1995): *Continuous Univariate Distribution,* 2nd Edition, John Wiley and Sons, New York.
3. Roy, M.K. (2014):*Fundamentals of Probability and Probability Distributions,* 8th edition.

Course Title: Algebra and Analytical Geometry

Course Code	Stat-123	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The purpose of this course is to develop the ability to use the basic methods of algebra and analytical geometry.

Objectives

The aim of the part Algebra is to -

- Use algebra as a tool for representing and solving a variety of practical problems.
- Use tables and graphs to interpret algebraic expressions, equations, and inequalities and to analyze behaviors of functions.
- Know the properties of real and complex numbers and why they are applicable
- Know the algebraic operations on complex numbers
- Explain what inequalities represent and how they are used
- Explain what it means for a sequence to have a limit (converge) or diverge.

The aim of the part Analytical Geometry is -

- Gaining knowledge including the mathematical notation and terminology used in this course
- Become familiar with the laws and formulas that result directed algebraic functions, polar coordinates, parametric, equations, and vectors
- How toderive equations in different forms (slope-intercept, point-slope, two point, intercept, parametric and perpendicular) of a line;
- Find the angle between two lines with given slopes;

Learning Outcomes

At the end of this, students should be able to-

- Define the terms "relation" and "function" and describe each of these mathematical concepts in a given context;
- Solve equations and inequalities, both algebraically and graphically
- Perform basic algebraic manipulation and understand the geometric interpretation of complex numbers
- Prove and apply the inequality of the means; the triangle inequality; the Cauchy-Schwarz inequality; Weierstrass' inequalities.
- Accurately identify the equations, properties and graphs of the parabola, circle and ellipse.

Course Contents

Algebra

Basic Concepts of Algebra: Concepts of Equation, Relations and Functions. Binary relation, Operation on Algebraic Expressions, Equivalence Relation, Properties of Real Number and Complex Number, and Definition of Group and Field.

Inequality: Order properties of real number, Arithmetic mean, Geometric mean, Weierstras's Inequality, Cauchy-Schwarz Inequality.

Theory of Equations: Binomial and Polynomial Equations, the Remainder Theorem in Algebra, Multiple Roots, Relation between Roots and Coefficients, Descarte's Rule of Signs, Symmetric Function of the Roots, Sum of the Powers of the Roots, Transformation of Equations, Limit of the Roots, Removal of any Terms of the Equations, Reciprocal Equation, Solutions of Cubic and Bi-Quadratic Equations.

Series: Basic concepts of series, Techniques of summing up series, Test of Convergence and Divergence of series.

Analytical Geometry

Basic Concepts about the Formation and History of Geometry, Cartesian and Polar Co-ordinates, Parameters, Changes of Axes Standard Equation in Different Co-ordinate Systems and their Parametric Representation.

Straight-line: Slope, Derivation of the Equation of Straight-line, Angle between Two Straight-line, Condition for Perpendicularity Parallelism Related Problems.

Pair of straight-lines: Concepts of Pair of Straight-line with Homogeneous form, General Equation of Second Degree, Reduction of Pair of Straight-line.

Coins: Ellipse, Parabola, Hyperbola, Circle & System of circle.

Text Book

1. Anton, H (2006): *Calculus with Analytic Geometry,* Wiley, New York.

Reference Books

1. Ayres, F. (1965): *Theory and Problems of Modern Algebra,* Schaum's Outline Series, McGraw-Hill Book Company.
2. Shahidullah, M. and Bhattacharjee, P. K.: *Text Book on Algebra and Trigonometry,* Latest edition.
3. Van Der Waerden, BL (1966): *Modern Algebra,* Frederick Ungar publishing Co., New York.

Course Title: Macroeconomics

Course Code	Stat-124	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The aim of this course is to equip students with the foundation skills essential for understanding the macroeconomic environment within which all entities operate. This course is a foundation course that will prepare students to be successful in upper division finance, marketing, business administration, economics, government, and social courses.

Objectives

Objective of this course is to-

- Provide an overview of macroeconomic issues: the determination of output, rates of growth, unemployment and inflation.
- Know the meaning and components of the National Income Accounts, especially GDP.
- Understand the meaning of the business cycle and its phases.
- Manipulate the basic Aggregate Supply, Aggregate Demand model of the macro economy.
- Know how fiscal policy operates, its tools, and its advantages and drawbacks
- Know how monetary policy operates, its tools, and its advantages and drawbacks.

Learning Outcomes

Upon successful completion of the course, students will be able to:

- Understand the behavior of the economy as a whole with major macroeconomic problems.
- Know the meaning of unemployment and inflation data and how that data is collected and computed.
- Understand how to calculate GDP, GNP and other major economic measurement.
- Define aggregate demand and supply for a good in a competitive market and explain how the aggregate demand and supply together determine equilibrium price.
- Understand the role money and monetary policy and how to allocate budget.
- Understand the inflation and its impact on economy along with economic growth and cycles.

Course Contents

Overall Economic Situation: Major Macroeconomic Problems – (Inflation, unemployment and low growth rate). Macroeconomic policy & goals. National Output Concepts. Measurement of National output, rates of growth, unemployment and inflation.

Aggregate Demand and Aggregate Supply Model: Determinants of Aggregate Demand – Consumption, Savings and Investment – Aggregate Supply – short run and long run. Determination of income in the very short run. Concept of Multiplier.

Money and Monetary Institutions: Types and Functions of money. Constituents of money supply. Role of Central Bank and Commercial Bank. Multiple expansion of deposits – Control of money supply. Demand for money – Quantity Theory of Money.

Role of Government and Fiscal Policy: Objectives of government – Objectives and instruments of fiscal policy. Budget – Deficit Budget and Surplus – Financing the deficit, Sources of Revenue, Direct and Indirect taxes, Government purchases and transfer payment.

Working of Monetary and Fiscal Policy: Monetary and Fiscal Policy in a closed economy. Open economy – Basis for trade Theory of Comparative Advantage – Perfect mobility of capital – Determination of interest rate – Exchange rate determination. Monetary and Fiscal Policy in an open economy. Multipliers in the short run and in the long run.

Inflation: Causes of Inflation, Cost Push and Demand Pull Inflation, Stagflation, Demand and Supply Side Factors of Inflation, Phenomenon of Phillips Curve.

Economic Growth and Cycles: Nature of business cycles. Sources of growth. Benefits and costs of growth. Theories of growth

Text Book

1. M. Parkin (2003): *Macroeconomics*, 6th Edition, Addison Wesley.

Reference Books

1. J.E.Stiglitz (1997): *Principles of Macroeconomics*, 2nd Edition, Norton & Company, Inc.
2. N.G.Mankiw (1997): *Macroeconomics*, 3rd Edition, Worth Publishers.
3. P.A.Samuelson and W.D.Nordhaus: *Economics*, 17th Edition.

Course Title: Programming With C

Course Code	Stat-125	Course Credit	03	Number of Class	35-40	Full Marks	100

(LAB)

Rationale

This Course intends to develop programming skills in the students, using a popular structured programming language 'C'.

Objectives

Objective of this course is to-

- Familiarize the students with basic concepts of computer programming and developer tools.
- Present the syntax and semantics of the "C" language as well as data types offered by the language
- Allow the students to write their own programs using standard language infrastructure regardless of the hardware or software platform

Solve following problem by using C language

- Determine correlation coefficients, strength, direction and significance level and then interpret the results in an appropriate way.
- Estimate the regression coefficients from the practical data and then fit a linear model to a bivariate data set via software
- Evaluate coefficient of determination (R^2), ANOVA table, F- test and T- test.
- Explore the basic ideas of analysis of attributes, Measures of association and construction of contingency table.

Learning Outcomes

After completing this course a student will able to-

- Gain insight programming language,
- General discuss flow chart of C-programming,
- Solve different statistical and mathematical problems using C-Programming.

Course Contents

Programming: Meaning, Algorithms, Flow Charting, list of Different Programming Languages, FORTRAN, C, C++, Mat lab, etc.

Programming in C: Introduction, Importance of C, Sample C Programs, Basic Structure of C Programs, Programming Style, Compilation and Execution of C Program. Sequential Structure. Character Set, Data Types, Classes of Data, Arithmetic Operations, Expressions, Assignment Statements, Input and Output. Selective Structure. Relational Operations, Logical Operations, Conditional Statements. Repetitive Structure. Functions, Arrays, Pointers, Structure. Applications of C program for Statistical Computation.

Different problem in bivariate statistics can be solved by using C.

Text Book

1. Byron S. Gottfried, (2005). Theory and Problems of Programming with C. 2nd Ed.

Reference Books

1. Rajaraman, V. (1999): *Fundamentals of Computers*, Prentice –Wall.

Course Title: Viva-Voce

Marks	50	Credits	02

Second Year
First Semester

Course Title: Sampling Distribution

Course Code	Stat-211	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The role of the course sampling distribution in statistical inference is astronomically relevant and essential. The concept of variants transformation and distribution of sample mean, sample variance, and sample covariance is utmost required to decision making in any field of statistical data analysis.

Objectives

Objectives of this course are-

- To present the general theory of statistical distributions.
- To present the standard distributions found in statistical practice.
- To present the relationships among distributions found in statistical practice.
- To provide a good grounding in the general theory of statistical distributions.

Learning Outcomes

Having successfully completed this course/module student will be able to:

- Derive both central and non-central chi-square, t and F distributions from normal distribution.
- Calculate moments and moment generating function.
- Recall definitions of probability function, density function, cumulative distribution function and moment generating function, and their inter-relationships
- Know in details variate transformation and Laplace transformation.
- Use moment generating function to determine distribution function and moments.
- Recall well known distributions such as Bernoulli, binomial, Poisson, geometric, uniform, exponential, normal, Cauchy, gamma and beta distributions and determine the relationship of those distributions with the central and non-central chi-square, t and F distributions.
- Construct the distribution of sample mean, sample variance, sample covariance and use these concepts in statistical inference.

Course Contents

Random Variable, Its Distribution and Properties, Functions of Random Variable; Sun Product and Ratio. Concept of Sampling Distribution, Variate Transformations: Square Root, Log, Sin Inverse, Fisher's Z Transformation, Laplace Transformation, Exact Sampling Distribution Related to Normal Population, Distribution of Sample Mean, Sample Variance, Sample Covariance. Central and Non-Central Distribution of t, Chi square (x^2), F, Chocran's Theorem, Fisher's Z and their Applications.

Text Books

1. Hogg, R. V. and Craig, A. T. (2002): *Introduction to Mathematical Statistics,* 5th edition, Pearson Education, Asia.
2. Mood, A M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics,* 3rd edition, McGraw-Hill, New York.

Reference Books

1. Arnold, B. C., Balakrishnan, N. and Nagaraja, H. N (2008): *A First Course in Order Statistics,* SIAM.
2. Rohatgi, V. K. and Saleh, A. K. Md. (2000): *An Introduction to Probability and Statistics,* Second edition, Wiley-Interscience.
3. Evans, M., N. Hasting and B. Peacock (2000): *Statistical Distributions,* 3rd edition, Wiley, New York.
4. Hoel, P. G. (1984): *Introduction to Mathematical Statistics,* 5th edition, John Wiley and Sons, New York.

Course Title: Sampling Techniques-I

Course Code	Stat-212	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This subject provides a broad introduction to census, sample survey and different probability and non- probability sampling. The subject is basically concerned with the appropriate sampling techniques to draw sample from population.

Objectives

The objectives of this course is to-

- Know about the basic concept of census and sample survey
- Understand the difference between probability and non- probability sampling.
- Choose the most appropriate sampling method according to the respective population
- Know the estimation procedure of certain parameters, and quantify the uncertainty in these estimates with a margin of error.

Learning Outcomes

After this course a student will able to-

- Distinguish design-based statistics (sampling methodology) from model-based statistics (usual methodology).
- Design studies using common probability sampling designs.
- Select a suitable sampling design, given available information and resources.
- Summarize data collected from a probability survey and understand methods to determine the accuracy of the estimators.
- Understand the different methodologies used to collect survey data.
- Design a sampling plan, conduct data collection, and summarize data into a report.

Course Contents

Introduction: Detailed Study of Census, Post Enumeration Check, Concept and Scope of Sampling, Census versus Sample Survey, Uses of Sample Survey, Principles of Sample Survey, Principle Steps in Sample Survey, Preparation of Questionnaire, Schedules, Instruction etc., Survey Enumeration, Pilot Survey, Requirement of a Good Sampling Design.

Non-Random Sampling: Purposive/Judgment Sampling, Quota sampling, Convenience Sampling and Snowball Sampling its Merits, Demerits and their Applications.

Probability Sampling: Procedure of Drawing a Probability Sample. Simple Random Sampling with and without Replacement, Stratified Random Sampling with different Allocation, Systematic Sampling, Cluster Sampling with Equal Probabilities. Estimation of Mean, Proportion, Ratio. Estimated Variance and Confidence Intervals, Sample Size Determination for Estimating Mean and Proportion.

Use of Auxiliary Information: Ratio, Difference, Regression and Product Methods of Estimation. Estimation of Population Total, Mean, Variance and Proportion.

Non-Sampling Errors: Sampling and Non-sampling errors, Bias, Accuracy and Precision, Sources and Remedies.

Text Books

1. Cochran, W.G. (2002): *Sampling Techniques,* 4th edition, Wiley Eastern, New Delhi.
2. Lohr, L.L (2009) *Sampling : Design and Analysis,* 2nd Edition, Advance Series

Reference Books

1. Murthy, M.N. (1977): *Sampling Methods,* 2nd edition, Statistical Publishing Society, Calcutta.
2. Islam, M.N.: *An Introduction of Sampling Methods: Theory and Applications.*
3. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984): *Theory of Survey with Applications,* 2nd edition, ISAS, New Delhi.

Course Title: Numerical Analysis

Course Code	Stat-213	Course Credit	02	Number of Class	20-26	Full Marks	50

Rationale

Numerical analysis is the study of algorithms that use numerical approximation for the problems of mathematical analysis. This course implement advanced numerical methods and apply them to a variety of problems in science and engineering.

Objectives

The objectives of this course is to-

- Give an introduction to commonly used numerical methods.
- Enable students to use numerical techniques to tackle problems in Statistics that are not analytically soluble.
- Demonstrate techniques for the solution of linear simultaneous equations.
- Explain and demonstrate the use of techniques for polynomial interpolation, spline fitting and soothing of data.
- Explain and demonstrate techniques for numerical integration.

Learning Outcomes

After successful completion of this course Students will be able to-

- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Analyze and evaluate the accuracy of common numerical method

Course Contents

Finite Differences: Factorial Notation, Shifting Operator, Difference Operator, Differential Operator and their Relationship, Difference Table.

Interpolation with Equal and Unequal Intervals: Concepts of Interpolation, Newton's Interpolation Formula, Relationship Between Simple Difference and Divided Difference. Newton's General Interpolation Formula, Lagrange's Formula, Inverse Interpolation, Method of Successive Approximations or Iteration and Reversion of Series.

Central Difference Interpolation Formula: Gauss Formula, Stirling's Formula and Bessel's Formula.

Numerical Differentiation and Integration: General Quadrature Formula, Simpson's Rule, Weddle's Rule, Trapezoidal rule, Euler Maclaurin's Formula and their Applications.

Solution of Algebraic and Transcendental Equations: Bisection Method, Method of False Position, Newton-Raphson Method, Method of Iteration.

Extrapolation: Concept of Extrapolation, Different Methods of Extrapolation

Text Book

1. Scarborough, J. B. (1966): *Numerical Mathematical Analysis,* 6th edition, Johns Hopkins Press, Baltimor.

Reference Books

1. Sastry, S. (1977): *Introductory Methods of Numerical Analysis,* 2nd edition, Prentice Hall, New Delhi.
2. Averil M. Law (2010): *Simulation Modeling and Analysis,* 4th Edition, Tata McGraw-Hill Education Private Limited, New Delhi

Course Title: Statistical Quality Control and Index Number

Course Code	Stat-214	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course will provide important knowledge and skills to monitor and improve the quality of service or industrial processes. Also it is possess much practical importance in measuring changes in the cost of living, production trends, trade, income variations, etc.

Objectives

The aim of this course is to-

- Make Understand the techniques and concepts of Statistical Quality Control and the meaning of the term index number
- Educate them, how to Construct the appropriate Quality Control charts / Forecasting and critically discuss the role of such charts / models in monitoring a process.
- Involve them in Assess the ability of a process to meet customer expectations.
- Get accustomed to the use of some widely used index numbers

Learning Outcomes

On completion of this course the student should be able to-

- Understand the history and requirements for effective quality systems in modern manufacturing
- Utilize the tools of quality systems
- Collect, analyze and plot variable and attribute data
- Create and react to control charts and describe various quality systems used in modern manufacturing
- Calculate required index number indices from given data.
- Appreciate the limitations of index numbers.

Course Contents

Statistical Quality Control: Meaning of Statistical Quality Control (SQC), Process Control and Product Control, Causes of Variation in Quality Product, Basic Principles of Quality Control, Control Chart Techniques, Various Attribute and Variable Control Charts, Acceptance Sampling and Sampling Inspection by Attributes and Variables, Sampling versus Screening, Sampling Plans - Single, Double, Multiple, Continuous Sampling Plans and their Relative Advantages and Disadvantages. Concept of OC, ASN, AOQ, AOQL, AQL and other characteristics of Sampling Plans, Sequential Sampling Plan, OC and ASN of Sequential Sampling. Total Quality Management (TQM).

Industrial Statistics: Sources of Industrial Statistics, Labour Statistics, Working Time, Indicator of Output Statistics, Statistics of Fixed Investment, Expenditure and Production Cost, Identification of Quality Level, Productivity of Labour Quality Control Measures.

Index Number: Meaning of Index Number, Problems Involved in Constructing Index Number, Construction of Index Number in Different Methods, Criteria of a Good Index Number, Unit Test, Time Reversal Test, Factor Reversal Test, Circular Test, Cost of Living Index Number, Economic Adviser's Wholesale Price Index Number, Consumer Price Index Number, Base Shifting, Splicing and Deflating of Index Number, Index of Industrial Production, Uses of Index Number and Limitations of Index Number.

Text Book

1. Montogomery, D.C. (2002): *Introduction to Statistical Quality Control*, 4th edition, John Wiley and Sons, New York.
2. Gupta, S.C. and Kapoor, V.K.: *Fundamental of Applied Statistics*.

Reference Books

1. Banks, J.: *Principles of Quality Control*, John Wiley and Sons, New York.
2. Duncan, A.J.: *Quality Control and Industrial Statistics*.
3. Goon, A.M., Gupta, M.K. and Dasgupta: *Fundamental of Statistics*, Vol II, The World Press Private Ltd., India.
4. Grant, E. (1988): *Statistical Quality Control*, McGraw-Hill Education.

Course Title: Advanced Calculus and Differential Equations

Course Code	Stat-215	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course builds on students previous experiences with functions of several variables and their developing and understanding of calculus and differential calculus.

Objectives

The aim of this course is to-

- Know the problem about limit, continuity and differentiability of function of several variables.
- Use Taylor's series, Lagrange's method of undetermined multipliers.
- Know Jacobeans transformation and their applications.
- Know multiple integrations, Dirichlet's integral and its extension.
- Know Laplace transformation and change of the order of integration.
- Identify initial value and Boundary value problem in differential equations.
- Know about homogeneous equations.
- Operate simultaneous differential equations

Learning Outcomes

On completion of this course the student should be able to-

- Solve the problem about limit, continuity and differentiability of function of several variables.
- Demonstrate Taylor's series, Lagrange's method of undetermined multipliers.
- Make Jacobeans transformation and their applications.
- Know multiple integrations, Dirichlet's integral and its extension.
- Know Laplace transformation and change of the order of integration.
- Identify initial value and Boundary value problem in differential equations.
- Evaluate about homogeneous equations.
- Operate simultaneous differential equations

Course Contents

Advanced Calculus: Function of Several Variables, Limit, Continuity, Differentiability of Function of Several Variables,Taylor's Series, Lagranges Method of Undetermined Multipliers, Jacobian of Transformation, and their Applications in Statistics.

Double, Triple and Multiple Integrations, Change of Variables, Dirichlet's Integral, and its Extension. Beta and Gamma Functions and their properties. Incomplete Beta and Gamma Functions. Fourier Series and Fourier Integrals, Transformations of Integrals, Existence of Laplace Transformation, Properties of Laplace Transformation, Inverse Laplace Transformation, their Application, Change of the Order of Integration.

Differential Equations: Definition, Classification, Origin and Application. Initial-value and Boundary-value Problems. Ordinary Differential Equations of First Order and Degree, Separation of Variables. Exact Equations. Separable Equations, Homogeneous Equations, and non-Homogenous Equations, Linear Equations, Bernoulli Equations, Linear Equation with Constant Coefficients, Simple Cases of Differential Equations of First Order and of Degree Higher than One, Partial Differential Equations of First and Second Order, Ordinary Simultaneous Differential Equations. Equation Reducible to Homogenous Forms and Homogenous Linear Equations.

Text Book

1. Anton, H (2006): *Calculus with Analytic Geometry*, Wiley, New York.
2. Ross, S.L. (1989): *Differential Equations*, 4th Ed., Wiley, N.Y.

Reference Books

1. Ayres, F. (1997): *Differential Equations*, McGraw-Hill, NY.
2. Ayres, F. and Meldelson, E. (1992): *Calculus*, McGraw Hill, 3rd edition, New York.

Course Title: Statistical Data Analysis- II

Course Code	Stat-216	Course Credit	03	Number of Class	35-40	Full Marks	100

Group A (Sampling Techniques-I):40 Marks

Rationale

This course is design to choose appropriate sampling methods for drawing sample from population and find the relative efficiency of different sampling scheme.

Objectives

The objectives of this course is to-

- Select a suitable sampling design, given available information and resources.
- Draw sample from population by using appropriate sampling techniques such as, Simple Random Sampling, Stratified Sampling, Systematic and Cluster Sampling
- Summarize data collected from a probability survey and understand methods to determine theaccuracy of the estimators.

Learning Outcomes

After successful completion of this course students will be able to-

- Select appropriate sampling techniques to draw sample from population
- Estimates the parameter and find the variance of estimates,
- Determine relative efficiency of different sampling scheme.

Course Contents

Drawing Samples by Simple Random Sampling, Stratified Sampling, Systematic and Cluster Sampling. Estimation of Parameters in Each Case. Estimation of Variance of Estimates, Estimates of Parameter, Determination of Precision of Estimates, Relative Efficiency of Different Sampling Scheme.

Ratio, Difference, Regression and Product Methods of Estimation, Estimation for Population Total, Mean, Variance and Proportion.

Text Books

1. Cochran, W.G. (2002): *Sampling Techniques*, 4th edition, Wiley Eastern, New Delhi.
2. Lohr, L.L (2009) *Sampling : Design and Analysis*, 2nd Edition, Advance Series

Group B (Numerical Analysis): 30 Marks

Rationale

Aim of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems on the computer.

Objectives

The objectives of this course is to-

- Provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration
- Improve the student's skills in numerical methods by using the numerical analysis software and computer facilities.
- Puts the practical basis of the random numbers generators from different distribution and analyze the simulated data

Learning Outcomes

After successful completion of this course students will be able to-

- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Numerically approximate functions with polynomials
- Apply appropriate techniques for numerical differentiation and integration

Course Contents

Newton's Forward and Backward Interpolation Formula, Newton's General Interpolation Formula, Lagrange's Interpolation Formula, Central Difference Interpolation Formula, Inverse Interpolation Formula, Numerical Integration (Simpson's Rule, Weddle's Rule, Trapezoidal Rule, Euler Maclaurence Formula.

Solution of Equation by Graphical Method, Bisection Method, Method of False Position, Newton Raphson Method, Method of Iteration.

Generating random variable from different distributions. Analyzing of simulating data.

Text Book

Scarborough, J. B. (1966): *Numerical Mathematical Analysis*, 6th edition, Johns Hopkins Press, Baltimor.

Group C (Statistical Quality Control and Index Number): Marks 30

Rationale

Statistical Quality Controlprovides a comprehensive coverage of statistical approaches and methods for industrial quality management. On the other hand second module (index number) provides an understanding of the modern theory and practice of index numbers as a means of making price and quantity comparisons.

Objectives

The objective of this course is to-

- Calculate basic statistical measures
- Construct control charts and develop sampling plans
- Explain process capability
- Familiar students with index numbers methods and to provide practical solutions to general aggregation problems
- Understand the competing merits of different approaches to index number problems and methods for dealing with quality change and new goods

Learning Outcomes

After completion of this course students will be able to-

- Understand control charts for variables
- Set Mean Chart(x-Charts), Range Chart(R-Charts)Limits
- Use Mean and Range Charts
- Identify the differences between x-bar, R-, p-, and c-charts
- Use control charts for attributes (p-charts and C-charts)
- Explain the process of acceptance sampling and describe the use of operating characteristic (OC) curves.
- Demonstrate knowledge and understanding of index numbers theory and methods and be able to provide practical solutions to general aggregation problems.
- Demonstrate knowledge and understanding of the competing merits of different approaches to index number problems and methods for dealing with quality change, and be able to choose appropriate methods for use in constructing an index number.

Course Contents

Construction of Different Control Charts and OC Curve, Drawing of ASN, AOQ, AOQL, AQL, Simple, Double and Multiple Sample Scheme.

Construction of Different Types of Indices by the Different Unweighted and Weighted Formulae, Tests of Index Number, Cost of Living Index Number.

Text Book

1. Montogomery, D.C. (2002): *Introduction to Statistical Quality Control,* 4th edition, John Wiley and Sons, New York.
2. Gupta, S.C. and Kapoor, V.K.: *Fundamental of Applied Statistics.*

Second Year
Second Semester

1 course → 32

Course Title: Statistical Inference-I

Course Code	Stat-221	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course is designed to introduce the students with fundamental concepts and techniques of statistical inference including estimation and test of hypotheses to be used in courses at advanced level.

Objectives

The aim of this course is to-

- Initiate students with the basic theory behind the development and assessment of statistical analysis techniques in the areas of point and interval estimation as well as hypothesis testing.
- Help the students to develop a deeper understanding of the basis underlying modern statistical inference.
- Able students to draw statistical inference from point estimates of estimated parameters and interpret these estimates.
- Acquaint/Equip students with a statistical tool kit which will enable them to apply their knowledge and skills to real world tasks.

Learning Outcomes

Upon successful completion of this course, students will acquire knowledge and skill to-

- Estimate unknown parameters of a given probability distribution using different methods of estimation.
- Explain in detail and demonstrate approaches to include a measure of accuracy for estimation procedures and our confidence in them by examining the area of interval estimation.
- Conceptually map the theoretical basis of tests of simple and composite hypotheses.
- Understand the broad directions of statistical inference and use this information for making informed choices in analyzing data.

Course Contents

Point Estimation: Principle of Point Estimation, Methods of Finding Estimators: Maximum Likelihood Estimation, Method of Moments, Method of Minimum?^2, Method of Least Squares, Method of Minimum Distance. Properties of Estimators: Closeness, Unbiasedness, Consistency, Fisher's Consistency, Sufficiency, Efficiency, Pitman Closer and Closest Estimator, Mean Squared Error, Loss Function, Risk Function. Minimax Estimator, Admissible Estimator, Correction for Bias, Consistent Asymptotically Normal (CAN) Estimators, Best Asymptotically Normal (BAN) Estimators, MVUE, Cramer-Rao Lower Bound, Completeness, Rao-Blackwell Theorem, Lehman-Scheffe Theorem.

Interval Estimation: Concept of Confidence Interval, Method of Finding Confidence Intervals: Pivotal Quantity Method and Statistical Method, Confidence Interval for Mean, Variance.

Test of Hypothesis: Simple hypothesis, Composite Hypothesis, Critical region, Best Critical Region, Two sided BCR, Steps of Hypothesis Testing, p-value, Test of Mean, Variance, Proportion, Correlation, Regression Coefficients, Test of Homogeneity in Parallel Samples.

Text Books

1. Cassela, G. and Berger, R. L. (2001): *Statistical Inference,* Wadsworth Publishing Company, California.
2. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics,* 3rd edition, McGraw-Hill, New York.

Reference Books

1. Kendall, M. and Stuart, A. (1979): *The Advanced Theory of Statistics,* Volume 2, 4th edition, Macmillan Publishing Inc., New York.
2. Hogg, R.V. and Craig, A. T (2009): *Introduction to Mathematical Statistics,* 6th edition, Pearson Education, Singapore.
3. Kendall, M.G. and Stuart, A. (2004): *Advanced Theory of Statistics,* 14th edition, Edward Arnold, New York.
4. Lehmann, E.L. and G. Cassela (1998): *Theory of Point estimation,* Springer Verlag, New York.

Course Title: Regression Analysis

Course Code	Stat-222	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course investigates the purposes, methods, applications of regression and its generalizations.

Objectives

The aim of this course is to-

- Develop a deeper understanding of the linear regression model and its limitations
- Acquaint students with Least Square methods and concept of linear regression, and its applications.
- Specify assumptions, formulate and estimate appropriate models, interpret the results and test their statistical significance..
- Understand both the meaning and applicability of a dummy variable and the assumptions which underline a regression model.
- Know how to diagnose and apply corrections to some problems in regression.

Learning Outcomes

At the end of this, students should be able to-

- Specify assumptions, formulate and estimate appropriate models, interpret the results and test their statistical significance.
- Know how to diagnose and apply corrections to some problems with the linear model found in real data
- Be able to understand both the meaning and applicability of a dummy variable
- To build polynomial regression models and Non -linear models.

Course Contents

Introduction: Meaning, Uses and Importance of Regression Analysis, Regression Model, Population Regression Line, Types of Regression Analysis.

Multiple Linear Regression: Multiple Regression Model, Regression Model in Matrix Notation, Model Assumptions, Estimation of Model Parameters by Ordinary Least Square (OLS) Method, Properties of OLS Estimators, Goodness of Fit: R2 , CP AIC, BIC, SIC and Model Selection Criteria. Inference about Regression Parameters, Confidence Interval, Prediction and Prediction Interval.

Validity of Assumptions and Examination of Residuals: Overall Plot, Time Sequence Plot, Plot Against Regression Equation, Plot against Predictor Variables, Other Residual Plots, Statistics for Examination of Residuals, Correlations among Residuals, Outliers.

Selection of Best Regression Equation: All Possible Regression, Best Set of Regression, Backward Elimination Procedure, Stepwise Regression Procedure.

Dummy Variables: Meaning nature of dummy variables, regression on different combination of quantitative and qualitative variables, comparing two regression by dummy variables, comparison with chow test.

Polynomial and Non-linear Regression: Polynomial Regression Models, Orthogonal Polynomials, Different Types of Non-Linear Regression and their Estimation Process.

Text Books

1. Draper, N.R. and Smith, H. (1998): *Applied Regression Analysis*, 3rd edition, John Wiley and Sons, New York.
2. Montgomery, D. C., Peck, E. and Vining, G.G. (2003): *An Introduction to Linear Regression Analysis*, 3rd edition, Wiley, New York.

Reference Books

1. Chatterjee, S. and Price, B.: *Regression Analysis by Examples*, Wiley.
2. Graybill F.A. (1961): *An Introduction to Linear Statistical Models*, Vol.1, McGraw Hill, New York.
3. Gujarati, D. (2003): *Basic Econometrics*, 4th edition, McGraw-Hill, New York.

Course Title: Real Analysis

Course Code	Stat-223	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

To expose the students to the basics of real analysis and complex variables for their subsequent course work. It is the part of the essential foundation for advanced study in many areas of pure and applied mathematics.

Objectives

The main aim of the part of real analysis is to-

- Define the real numbers, least upper bounds, and the triangle inequality.
- Define the limit of a function at a value, a limit of a sequence, and the Cauchy criterion
- Describe continuity of a function and uniform continuity of a function
- Recognize alternating, convergent, conditionally and absolutely convergent series. prove various theorems about the derivatives of functions and emphasize the proofs' development
- Prove the Rolle's theorem, extreme value theorem, and the Mean Value theorem and emphasize the proofs' development
- Define Riemann integrable and Riemann sums and prove various theorems about Riemann sums and Riemann integrals and emphasize the proofs' development.

Learning Outcomes

By the end of the course, students should be able to-

- Describe fundamental properties of the real numbers that lead to the formal development of real analysis and comprehend rigorous arguments developing the theory underpinning real analysis
- Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration
- construct rigorous mathematical proofs of basic results in real analysis;
- Determine several representation of complex number.
- Calculate the limit of a sequence and a complex function.
- Find complex derivative and a formal derivative.
- Knows fundamental functions of one complex variable and calculate the complex integral along the path.
- Apply cauchy theorem and cauchy formula.

Course Contents

Series: Function and Real Valued Function. Open set, Dense Set, Countability, Compact, Connected sets, Monotonic Class of Sets and Additive Class of Sets. Convergence Principle, Convergence and Absolute Convergence of Series. Comparison Test, Ratio Test, Root test and Integral Test. Rearrangement of Absolute Convergent Series, Cauchy's Convergence, Multiplication of Absolutely Convergent Series.

Real Functions: Continuity, Uniform Continuity, Properties of Continuous Functions, the Exponential, Logarithmic, Trigonometric Functions, Rolle's Theorem, Mean Value Theorems, Cauchy's Mean Value Theorem, Taylor's Theorem with Lagrange's and Cauchy's form of the Remainder.

Riemann Integral: The Existence of the Riemann Integral of a Continuous Function, Simple Properties, First and Second Mean Value Theorem, Convergence and Absolutely Convergence of Improper and Infinite integrals, Sequences and Series of Functions, Uniform convergence, Comparison Test, Term by Term Integration and Differentiation.

Text Books

1. Rudin, W (1976): *Real Analysis, Academic Press,* New York.

Reference Books

1. Apostol, T. (1992): *Mathematical Analysis,* McGraw Hill, New York.
2. Binmore, G.H. (1965): *Foundation of Analysis,* Books I & II, C.U.P., London
3. Burkill, J.C. (1962): *A First Course in Mathematical Analysis,* C.U.P., London
4. Chowdhury, B: *Elements of Complex Analysis.*
5. Churchill, V.R.: *Complex Variable.*
6. Courant, H. (1988): *Differential and Integral Calculus,* Vol. II & III, Blackie.

Course Title: SPSS, STATA and SAS

Course Code	Stat-224	Course Credit	03	Number of Class	35-40	Full Marks	100

(LAB)

Rationale

This course introduce two statistical package SPSS and STATA for data analysis and programming language SAS is also introduce for reading and writing data from program.

Objectives

The primary objective of the course is to-

- Learn basic data analysis with SPSS, STATA and SAS.
- Learn how to enter data, define variables, and perform variable manipulation and transformation as well as analyze the data. Specifically, reading and writing SPSS, STATA, SAS and others files types with different formats; Survey coding and data entry; selected data management procedures; and Data analysis and interpretation with SPSS, STATA and SAS.

Learning Outcomes

Upon successful completion of the course, students will be able to-

- Apply the basic statistical tools learnt in the introductory course.
  - Manipulate variables
  - Transform data for analysis
  - Recode and compute variables
  - Describe data
- Understand the basic principles for choosing and conducting basic statistical tests.
- Reading and Writing data set in STATA in different formats.
- Manipulate (Merge, Sort, drop, add,) data and variables in STATA
- Learn STATA commands for different probability distribution
- Perform different operation (algebraic, matrix) in STATA
- Use STATA to solve different statistical problem (Estimation, Regression, ANOVA, Hypothesis Testing)
- Perform the following basic statistical tests using SPSS, STATA and SAS:
  - Basic Statistics
  - Correlation Regression
  - T-test
  - ANOVA
  - Chi-square

  Non-parametric alternatives

Course Contents

SPSS: Meaning of SPSS, Concepts of Commands, Syntax Diagram, Running Commands in Inter-relative and Batch Mode, Sub-commands, Keywords, Values in Command Specifications, String Values in Command Specifications, Delimiters Command Order. Operation Commands, Data Definition and Manipulation Commands, File Management in SPSS, Commonly Used Procedure Commands for Data Analysis.

Data Read, Write, Export, Import, Merge, Combining, Match, Updating, Transformation: Computing Recoding Variables. File Handling, File Transformations: Sub-setting, Sort Cases, Add Cases and Variables, Select Cases, Weight Cases.

STATA: Concept about the different windows in STATA, Converting data into STATA format from other formats by Stat Transfer, importing and exporting data, data entry, data cleaning, And data management: imputing, editing data, creating and changing variables, saving and reusing data, data reorganization, data merging and appending, basic STATA Commands, STATA commands for different probability distributions. Vector operation. Matrix operation: Transpose, Addition, Subtraction, Multiplication and Inversion. Solution of simultaneous equations.

SAS: Overview, List Directed and Column Input, Pointers and Formats, Reading Structured and Unstructured Data Format List. Reading and Writing Raw and System Files, Reading and Writing Data from Program and ASCII Data from External File, File Options, Writing Data to External File, Creating and Reading Permanent SAS Data Set, Working with Large Data Sets Problems.

Reading Data from Different Formatted Data Files, Converting Different Database Formatted Files to SAS System Files. Data Set Sub-setting, Concatenating, Merging and Updating Sub-setting, Combining Different Data from Multiple Files, Table Look Up, and Updating Master File form Update File. Use of Array for Missing Values to Create New Variables, Transformation of Data Set, Temporary Arrays, Multidimensional Arrays.

Data Analysis: Computing Descriptive Statistics, Correlation, Regression, Comparing Group Means, Analysis of Categorical Data, Tests, and Analysis of Variance, Demography, Graphical Representation by Using SPSS, STATA and SAS.

Text Books

1. Norusis, M. J. (1988): *A Guide SPSS/PC for Data Analysis,* SPSS Inc., USA.
2. Delwiche, L. D. and S. J. Slaughter (2003): The Little SAS Book: SAS Institute Inc., Cary, NC, USA

Reference Books

1. Cleophas, T.J. and A.H. Zwinderman (2010): SPSS for Starters, Springer.
2. Cody, R.P. and Smith, J.K. (1991): *Applied Statistics and the SAS Programming Language,* 3rd edition, Prentice Hall, Inc., New Jersey.

Course Title: Statistical Data Analysis- III

Course Code	Stat-225	Course Credit	02	Number of Class	20-26	Full Marks	50

Regression Analysis: Marks 50

Rationale

This course focuses on building a greater understanding, theoretical underpinning, and tools for applying the linear regression model and its generalizations.

Objectives

The objective of this course is to-

- Estimate the regression parameter by using appropriate methods and fit a regression line.
- Use different model selection criteria to choose appropriate model.
- Test the significance of regression coefficients and then find confidence interval for these coefficients.
- Detect outliers by using appropriate methods.

Learning Outcomes

After successful completion of this course students will be able to-

- Fit a regression line after estimating parameter and then interpret the results perfectly
- predict future value by using the fitted model
- Choose appropriate model by using different model selection criteria.
- Determine significant regression coefficient and find the confidence interval for this coefficient.

Course Contents

Estimate the Regression Model, Construction of Fitted Line, Calculation of Coefficient of Determination, Correlation Coefficient, Different Model Selection Criteria, Test of Significance of Regression Coefficients, Confidence Interval for Regression Coefficients, and Detection of Outliers by Different Methods.

Text Books

Montgomery, D. C., Peck, E. and Vining, G.G. (2003): *An Introduction to Linear Regression Analysis,* 3rd edition, Wiley, New York.

Course Title: Viva-Voce

Marks	50	Credits	02

Third Year
First Semester

Course Title: Stochastic Process

Course Code	Stat-311	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The course is designed to equip students with theoretical knowledge and practical skills, which are necessary for the analysis of stochastic dynamic systems in economics, engineering and other fields.

Objectives

The main purpose of this course is to-

- Develop and analyze probability models that capture the salient features of the system under study.
- Identify appropriate stochastic process model(s) for a given research or applied problem.
- Predict the short and long term effects that this randomness will have on the systems under consideration.
- Present Markov chain models, martingale theory, and some basic presentation of Brownian motion, as well as diffusion and jump processes.
- Discuss the convergence stability analysis of (discrete generation) Markov chains. The course will also be illustrated with a variety of applications.

Learning Outcomes

By the end of this course you should be able to-

- State the defining properties of various stochastic process models.
- Sample on a computer any type of continuous or discrete time stochastic process.
- Identify appropriate stochastic process model(s) for a given research or applied problem.
- Provide logical and coherent proofs of important theoretic results.
- Solve Random Walk and Ruin Problem.
- Apply the theory to model real phenomena and answer some questions in applied sciences.

Course Contents

Stochastic Process: Concept, definition, state space, parameter space, classification of stochastic process.

Markov Chain: Concept, definition, conditional probability, transition probability function, one and n-step transition probability, Higher transition probabilities, classification of states and chains, properties of communication of states, Chapman Kolmogorov equations, first entrance decomposition formula.

Counting Process: Counting process, Poisson process, stationary and independent increment, arrival and waiting time distribution, conditional distribution of inter-arrival time, compound poison process.

Random Walk and Ruin Problem: The classical ruin problem, probability of ruin, effect of change of state, expected duration of the game, expected game.

Markov Process: Pure birth process, pure death process, birth and death Processes.

Renewal Theory: Renewal event, recurrent event, delayed recurrent event, Renewal Process, Distribution of N(t), Limit Theorems and its application, Renewal reward process, Regenerative Process, Cyclic Renewal, alternative renewal process, branching process.

Queuing theory: Concept of queue, characteristics of queuing system, steady state probabilities, exponential queuing models, tandem or sequential system, M/G/I system, Erlang's loss system, M/M/K queue system, distribution of queuing and waiting time.

Text Books

1. Ross, S. M.: *Introduction to Probability Models*, 9th edition, Academic Press.
2. Bhat, U.N. (1981): *Elements of Applied Stochastic Processes*, 2nd Edition, Wiley, New York.

Reference Books

1. Mehedi, J, (1994): *Stochastic Process*, 2nd Ed, Wiley Eastern Ltd, New Delhi.
2. Barlett, M.S: *An Introduction To Stochastic Process*, 5th Ed.
3. Cox, D.R. and Miller, H.D: *Theory of Stochastic Process*, Vol. I and II, Wiley Easter, New Delhi.

Course Title: Design of Experiment-I

Course Code	Stat-312	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course is designed to introduce the students with basic concepts and techniques used in the design and analysis of experiments. The concepts and different models of an experimental design will be studied, leading to their statistical analysis based on linear models.

Objectives

The objective of this course is to -

- Give students a sound understanding of experimental design
- Able students to understand the importance of statistical design of experiments and benefits in different field.
- Teach the students how to verify the hypothesis in an efficient way.
- Explore the method of analysis of variance and show how it is structurally linked to particular types of design.
- Introduce the logic, application, and interpretation of analysis of variance (ANOVA) models.
- Give idea about missing value & learn how to deal with different designs if there exists any missing value in the data.

Learning Outcomes

On completion of this course students will be able to-

- Critically review basic concepts and models of experimental design.
- Describe the basic principles behind design of experiment.
- Construct the design matrix for simple experiments and estimate their parameters.
- Perform an analysis of variance on standard experimental designs.
- Distinguish between different designs and recognize their efficiency / utility.

Course Contents

Basic Concept: Some Basic Definitions, Basic Principles of Experimental Design, Requirements of a Good Experiment, Analysis of Variance, Linear Statistical Model, Parametric Function, Contrasts, Analysis of Variance on One-Way Classification, Two-way Classification with one Observation Per Cell, Two-way (cross) Classification With Multiple but Equal Number of Observations Per Cell, Three-way Classification With single Observation Per Cell, Three-way (cross) Classification With Multiple but Equal Number of Observations Per Cell. Steps Involved in an Experiment, General Rules for df and Expected Mean Squares.

Basic Design: Introduction, Completely Randomized Design, Randomized Block Design, Latin Square Design, Orthogonal Latin Squares, Non-orthogonal Two-way Classifications.

Orthogonally of Design and Missing Values: Introduction, Missing Data in Randomized Block Design, Missing Data in Latin Square Design.

Variance Component Analysis, Method of Variance Component Analysis, Variance Component Analysis in One Way, Two Way and Three Way Classified Data.

Text Books

1. Montgomery D. C. (2005): *Design and Analysis of Experiments*, 6th edition, Wiley, USA.
2. Rao P.V. (1997): *Statistical Research Methods in the life Se.*

Reference Books

1. Das, M. N. and N. C. Giri (1986): *Design and Analysis of Experiments*, 2nd Edition, Wiley Eastern, India.
2. Bhuiyan, M. R.: *Experimental Design.*
3. Cochran, W.G. and Cox, G.M. (2000): *Experimental Design*, 2nd Edition, Wiley, New York.
4. Fisher, R.A. (1995): *The Design of Experiments*, 8th edition, Hafner, New York.

Course Title: Introductory Demography

Course Code	Stat-313	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Demography or population studies tackle questions surrounding the structure and dynamics of populations. It is concerned with life events of individuals: birth, marriage, migration and death. Introductory demography is designed to make the students oriented with the concept of vital statistics and to be used in courses at advanced level.

Objectives

The objectives of this course is to-

- Acquaint students with the basic tools of vital statistics.
- Help them conceptualize basic demographic measures.
- Develop skills to analyze fertility and reproduction, mortality and graduation.
- Construct life table and analyze different types of life table.
- Make the students to understand about marriage and Nuptiality.
- Gather knowledge about migration and urbanization.

Learning Outcomes

After completing this course students will able to-

- Gather basic knowledge regarding concepts of vital statistics and their uses and interpolation.
- Sources of demographic data and method of data collections.
- Demonstrate rates, ratio, and population growth and population projection.
- Analyze fertility and reproduction of population.
- Gather knowledge about mortality and graduation.
- Construct life table and interpret the life table.
- Gather knowledge about marriage, nuptiality and urbanization.

Course Contents

Introduction: Concepts of Vital Statistics and their Uses and Interpretation, Census, Vital Registration, Sample Survey, Meaning of Demography, Nature and Scope of Demography. Sources of Demographic Data, Methods of Data Collection, Concepts of De Facto and De Jure Census.

Demographic Measures: Rates of Vital Events, Concept of Population Change, Population Growth, Measurement of Population Growth, World Population Growth, Population Projection.

Fertility and Reproduction: Concept of Fertility, Reproduction, Causes of Low and High Fertility, Measurements of Fertility and Reproduction, Fertility, Trends and Differentials, Standardization and Decomposition of Fertility Rate.

Mortality and Graduation: Concepts of Mortality and Morbidity, Measures of Mortality, Trends of Mortality, Differentials, Mortality, Direct and Indirect Standardization of Morbidity Rates, Graduation of Population Data, Graduation of Mortality Rates, Makeham's Graduation formula.

Life Table: Concept of Life Table, Types of Life Table, Functions of a Life Table and Relationship Between Life Table Columns, Construction of a Life Table, Application of Life Tables, Forces of Mortality.

Marriage and Nuptiality: Concept of Marriage and Nuptiality, Family Formations, Composition and Dissolution; Estimation of Mean and Median age at Marriage, Estimation of Singulate Mean age at Marriage.

Migration and Urbanization: Concepts of Migration, Types and Measures of Migration, Consequences, Determinant's and Trends of Migration, Logistic Curve, Fitting the Curve by Different Methods, Urbanization and Measures of Urbanization.

Text Books

1. Barclay, J.: *Techniques of Population Analysis*, Wiley, New York.
2. Shryock, H. S., J. S. Siegel and Associates (2004): *The Methods and Materials of Demography;* Latest edition, Academic Press, N.Y.

Reference Books

1. Biswas, S. (1988): *Stochastic Process in Demography and Applications*, Wiley Eastern, New Delhi.
2. Misra, B.D.: *An Introduction to the Study of Population*, South Asia, New Delhi.
3. Spiegelman, M.: *Introduction to Demography*, Harvard University Press, USA.

Course Title: Time Series Analysis

Course Code	Stat-314	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course introduces a variety of statistical models for time series and covers the main methods for analyzing these models. This also highlights the usefulness of theoretical time series techniques for understanding data patterns and explores dynamic causal linkages.

Objectives

The main objective is to-

- Define and explain terminology used to describe time series, including trend, seasonal effects, cyclical effects, outlier and white noise
- Identify, estimate and conduct inferences in time series models
- Investigate historical development.
- Forecast future development.
- Test an economic theory.
- Give an introduction in the statistical modeling and prediction of economic and financial time series.

Learning Outcomes

After completing the course the students will be able to-

- Understand the central ideas of time series analysis and forecasting
- follow literature in applied economics using time series analysis
- implement the most common techniques to real-world forecasting problems
- use time series analysis to test economic theory empirically
- model financial volatility
- Elements of Time Series Analysis and Forecasting
- How to handle Seasonality and Cycles in Forecasting
- Case Studies and Applications
- Model non-stationary time series variables that evolves simultaneously over time.
- Understand the theoretical properties of estimators and test statistics involving time series models.

Course Contents

Introduction: Meaning and objectives of Time series, the different component of time series, measurement of secular trend, seasonal, cyclical and irregular component, elimination of the seasonal, cyclical and irregular components, simple time series models, stationary models,

Stationary Processes: Basic properties, linear processes, ARMA processes, properties of sample mean and autocorrelation function, forecasting stationary time series, world Decomposition problems.

ARMA Models: ARMA (p,q) process, ACF and PACF of ARMA (p, q) process, Preliminary estimation, maximum likelihood estimation, diagnostic checking, forecasting order selection, problems.

Spectral Analysis: Spectral Densities, periodogram, time invariant linear filters, spectral density of ARMA process problems.

Non-stationary and seasonal time series models: ARIMA models for non-stationary time series, identification techniques, unit roots in time series models, forecasting ARIMA models seasonal ARIMA (SARIMA) models, regression with ARMA errors.

Multivariate time series: Second order properties, mean and covariance function, multivariate ARAMA (MARMA) models, best linear predictors, modeling and forecasting with MAR or VAR Process. VAR Models, unit root models error correction model, cointegration analysis.

State-Space Models: State-space representation, basic structural mode, state-space representation of ARIMA models, Kalman recursions, estimation for state-space models, state-space models with missing observations, EM algorithm, generalized state-space models.

Text Books

1. Brockwell,P. J. and Davis, R. A. (2002): *Introduction to Time Series and Forecasting;* Springer New York.
2. Makridakis, S., Whellwright, S. C. and Hyndman ,R. J. (1998): *Forecasting Methods and Applications,* 3rd Edition, John Wiley and Sons, New York
3. Box, G., Jenkins, G. M. and Reinsel, G. (2008): *Time Series Analysis: Forecasting and Control,* 3rd edition, Wiley, New York.

Reference Books

1. Chris Chatfield: *The Analysis of Time Series,* 6th Ed, CRC PressTaylor& Francis Group.
2. Cooray, T.M.J.A.: *Applied Time Series, Analysis and Forecasting,* Narosa Publishing House Pvt Ltd.
3. Gujrati,D. (2003): *Basic Econometrics* 4th Ed, McGraw-Hill, New York.
4. Hamilton, J. D. (1994): *Time Series Analysis,* Princeton University Press, New Jersy
5. Harris, R. and Robert, S. (2003): *Applied Time Series,* ReplicaPressPvt, Ltd
6. Montogomery, D.C, Johnston, L. A., Gardiner, J. S.: *Forecasting and Time Series Analysis* , 2nd Ed.

Course Title: Econometrics-I

Course Code	Stat-315	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course provides the methodology and statistical techniques to test empirically the validity of economic hypotheses and to construct models to explain the evolution of the economic environment.

Objectives

The main objective is to-

- Introduce regression analysis to students so that they are able to understand its applications in different fields in economics.
- Know the nature, scope and sources of econometric data.
- Know the assumption of classical linear regression model
- Understand the econometric modeling and model selection.

Learning Outcomes

After the end of the course, students will be able to-

- Specify assumptions, formulate and estimate appropriate models, interpret the results and test their statistical significance.
- Conduct research in teams where they apply the techniques learnt during the course and present their results.
- Write a good quality undergraduate research paper in economics using the econometric methods taught in the class.

Course Contents

Concept: Meaning, economics and econometrics, types of Econometrics, nature, scope and sources of econometric data.

Multicollinearity: Concept of multicollinearity, estimation in presence of multicollinearity, theoretical and different consequences of multicollinearity, detection of multicollinearity, remedial measures of multicollinearity, Ridge Regression.

Heterosedasticity: Meaning of heteroscedasticity, Ordinary Least Square(OLS) and Generalized Least Square (GLS) estimation in presence of heteroscedasticity, consequences of using ordinary least squares in presence of heteroscedasticity, detection of heteroscedasticity by both informal and formal methods, Park, Glejser, Spearman's rank correlation, Goldfield-Quandt, and Breusch-Pagan-Godfrey test of heteroscedasticity, remedial measures of heteroscedasticity.

Autocorrelation: Concept of autocorrelation, Ordinary Least Squares estimators and best linear unbiased estimators, estimation in presence of autocorrelation, consequences of using ordinary least squares in presence of autocorrelation, detection of autocorrelation by graphical methods, run test, Durbin-Watson D-test, H-test asymptotic autocorrelation, remedial measures of autocorrelation for both known and unknown p, Ceohrance-Orcutt Iterative, Durbin's two step and EGLS methods of estimating p, concept of autoregressive conditional heteroscedasticity (ARCH) model, generalized ARCH (GARCH) model.

Econometric Modeling and Model Selection: Average economic regression, methodology and specification errors, types of specification error, nature, consequences and remedies of specification errors, test of specification error, errors of measurement in dependent and explanatory variables, Monte-Carlo experiment of specification error, Different model selection criteria.

Text Books

1. Gujrati,D. (2003): *Basic Econometrics* 4th edition, McGraw-Hill, New York.
2. Greene, W.H. (2003): *Econometric Analysis*, 5th Ed, Pearson Education

Reference Books

1. Johnston, J. (1977): *Econometric Methods*, 4th edition, McGraw-Hill, New York.
2. Desai, M. (1976): *Applied Econometrics*, Oxford Publication.
3. Kleim& Miller: *An Introduction to Econometrics*.

Course Title: R and Python

Course Code	Stat-316	Course Credit	03	Number of Class	35-40	Full Marks	100

(LAB)

Rationale

R and Python are both based on statistical data analysis software. Sometimes it is very difficult to find the exact tools to analyze data in GUI based software, in that case both R and Python is very handy, though in both software we can make our own function, tools, adds-in.

Objectives

The main objective of this course is providing students all the basic and advanced knowledge of R and Python.

Learning Outcomes

After the end of the course, students will be able to-

- Understand the basic environment of R and Python
- Reading and Writing data set in R in different formats.
- Learn R commands for different statistical purpose.
- Use R to solve different statistical problem (Estimation, Regression, ANOVA, Hypothesis Testing)
- Know how to download and install R in windows.
- Learn about data series and data frame in R environment.
- Solve different probability related problems in Python.
- Learn different logical statement and create looping R.
- Solve different statistics related problem (Estimation, Regression, Hypothesis Testing, ANOVA, and Sampling) with Python.

Course Contents

R: Downloading and installing R, Simple R session with some basic commands, case-sensitivity, recall and correction of previous commands, assignments and expressions, simple manipulations of numbers, getting help on R, Making list and data frames, attaching and detaching data frames. Executing commands from a file, diverting output to a file.

Obtaining densities, cumulative probabilities, quartiles and random samples from different probability distributions.

Conditional execution with if statement, repetitive execution with for, repeat and while statements. Writing R functions, Arguments and defaults, Assignments within functions, Returning multiple objects as output.

Reading data from file, Importing data from files created by other software.

Python:

Downloading and Installing Python: Introduction to Python, IPython (3.7.0) and IPython Notebook. Installing Python using PIP command.

Programming Basics and Strings: Introduction, How Programming Is Different from Using a Computer Programming, The First Steps, and Starting code Editor, Using code Editor's Python Shell.

Numbers and Operators: Different Kinds of Numbers, Numbers in Python, Creating an Imaginary Number, Number Formats, Formatting Numbers as Octal and Hexadecimal.

Variables: Names for Values, Referring to Data – Using Names for Data, Assigning Values to Names, Copying Data, Manipulating, Slicing, Retrieving data set.

Packages of python: Pandas, Numpy, and Scipy.

Applications of R and python in Statistics: Basic statistical techniques, graphs, correlation and regression, estimation of parameters of multiple regression model, inference in multiple regression, partial correlation, multiple correlation and related tests, model selection, fitting polynomial regression, examination of residuals, outliers, influential points.

Text Books

1. Mark Lassoff, Julius Hernandez(2018): Introduction to Python, Kindle Edition.
2. Dalgaard, P. (2008). Introductory Statistics with R, 2nd edition, Springer.
3. Everitt, B. and Hothorn, T. (2006): A Handbook of Statistical Analysis using R. Champman & Hall.

Reference Books

1. Chambers, J.M. (2007): Software for data Analysis: Programming with R. Springer.
2. Venables, W. N. and D. M. Smith (2013). An Introduction to R, the R Core Team.

Course Title: Statistical Data Analysis- IV

Course Code	Stat-317	Course Credit	02	Number of Class	20-26	Full Marks	50

Group A (Econometrics-I): 30 Marks

Rationale

This course is to introduce an appropriate alternatives to ordinary least squares, when assumptions underlying the classical linear regression model are violated.

Objectives

The course objectives are-

- To estimate a model in the presence of multicollinearity, heteroscedasticity and autocorrelation
- To test whether multicollinearity, heteroscedasticity and autocorrelation are arises in model.
- To use various remedial measures of multicollinearity, heteroscedasticity and autocorrelation
- To use Durbin H-test, Granger causality test for detecting autocorrelation

Learning Outcomes

After successful completion of this course students will be able to-

- Detect multicollinearity, heteroscedasticity and autocorrelation in a model
- estimate a model in the presence of multicollinearity, heteroscedasticity and autocorrelation
- use various remedial measures of multicollinearity, heteroscedasticity and autocorrelation

Course Contents

Estimation of models in presence of multicollinearity, heteroscedasticity, autocorrelation, tests and remedial measures of multicollinearity, heteroscedasticity, autocorrelation, different procedures of model specification error, regression with dummy variables, probability models, estimation of different dynamic econometric models, detecting autocorrelation in autoregressive model by Durbin H-test, Granger causality test.

Text Book

Gujrati,D. (2003): Basic Econometrics 4th edition, McGraw-Hill, New York.

Group B (Time Series Analysis): 20 Marks

Rationale

This course will provide an introduction to time series models in common use and their use for predicting future observations and/or estimating unobservable components like trend, seasonal, cyclical and irregular effects.

Objectives

The objectives of this course are to-

- Understand and be able to apply the concepts and methods underlying the analysis of univariate time series, and the context for interpretation of results
- Decompose a time series into trend, seasonal, cyclical and irregular components
- Use various time series model such as moving average (MA), weighted MA, exponential smoothing, AR, ARMA, ARIMA, SARIMA etc for forecasting univariate time series data
- Use multivariate time-series models such as vector auto regression (VAR) to analyze time series data

Learning Outcomes

- Decompose a time series into trend, seasonal and irregular components
- Identify statistical models and techniques that are appropriate for a particular type of time series data
- Estimate and conduct inferences with time series models

Course Contents

Measurement of secular trend, seasonal, cyclical and irregular components, time series plot, estimation and forecasting by moving average (MA), weighted MA, exponential smoothing, AR, ARMA, ARIMA, SARIMA etc., correlogram analysis, spectral decomposition, VAR model, cointegration analysis.

Text Book

1. Brockwell,P. J. and Davis, R. A. (2002): *Introduction to Time Series and Forecasting;* Springer New York.
2. Gujrati,D. (latest ed): *Basic Econometrics* 4th Ed, McGraw-Hill, New York.

Course Title: Statistical Data Analysis- V

Course Code	Stat-318	Course Credit	02	Number of Class	20-26	Full Marks	50

Group A (Design of Experiment-I): 20 Marks

Rationale

This course is design to impart students a general view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications.

Objectives

Objectives of this course are to-

- Understand the issues and principles of Design of Experiments.
- Identify situations where one-way/two-way/three-way (fixed effects, mixed effects and random effects models) ANOVA is and is not appropriate.
- State the modeling assumptions underlying ANOVA and also state the null and alternative hypotheses for the ANOVA test.

Learning Outcomes

After successful completion of this course students will be able to-

- Estimate one-way/two-way/three-way (fixed effects, mixed effects and random effects models) ANOVA.
- Test the appropriate hypothesis for the ANOVA test.
- Understand the principles of Design of Experiments.

Course Contents

Analysis of variance in one way, two way and three way classification with equal number of observations per cell with fixed effects, mixed effects and random effects models, variance component analysis in one way, two way and three way classified data, Introduction to CRD,RBD and LSD; Missing data in RBD and LSD.

Text Book

1. Montgomery D. C. (2005): *Design and Analysis of Experiments*, 6th edition, Wiley, USA.
2. Rao P.V. (1997): *Statistical Research Methods in the life Se.*

Group B (Stochastic Process): 15 Marks

Rationale

This course introduce the idea of a stochastic process, and to show how simple probability and matrix theory can be used to build this notion into a beautiful and useful piece of applied mathematic

Objectives

The objectives of this course are to-

- Generate Markov chain, Transition probability matrix with real world phenomena.
- Develop Homogeneous and non-homogeneous Poisson process.
- Analyze of Queuing Theory and application of the theory to real-world problem.
- Test of Markov chain.

Learning Outcomes

At the end of this course students will able to-

- Understand the notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains;
- Understand notions of long-time behavior including transience, recurrence, and equilibrium;
- Apply these ideas to answer basic questions in several applied situations including genetics, branching processes and random walks.
- Apply queuing theory to real-world problem.

Course Contents

Markov Chain, Transition Probability, Transition Probability Matrix, Probability Distribution, Limiting Distribution, Transition Graph, Chapman-Kolmogorov Equation, Classification of States and Chains, First Entrance Decomposition Formula, First Passage Time Distribution, Determination of Higher Transition Probabilities, Properties of Reducible and Irreducible Chains, Statistical Inference for Markov Chains, Homogeneous and No-homogenous Poisson Process, Markov Process, Renewal Theory and Different Queuing Systems.

Text Book

1. Ross, S. M.: *Introduction to Probability Models,* 9th edition, Academic Press.
2. Bhat, U.N. (1981): *Elements of Applied Stochastic Processes,* 2nd Edition, Wiley, New York.

Group C (Introductory Demography): 15 Marks

Rationale

To introduce students to the core demographic methods and to provide practical experience using such methods.

Objectives

The objectives of this course is to-

- Present Demographic Data by Graphs and Charts
- Know the computation procedure of different rates and ratios(such as, Growth Rates, TFR, GRR,NRR,ASFR etc.) of demographic data
- Construct life table and analyze different types of life table.
- Project population by using appropriate methods

Learning Outcomes

After successful completion of this course students will be able to-

- Identify principal sources of demographic data and assess their strengths and weaknesses
- Calculate different rates and ratios and then interpret the results in a perfect way
- Identify the components of population change, including the effects of changing birth, death and migration rates.
- Construct and interpret different life tables.
- Identify principal sources of demographic data and assess their strengths and weaknesses
- Calculate different rates and ratios and then interpret the results in a perfect way
- Identify the components of population change, including the effects of changing birth, death and migration rates.
- Construct and interpret different life tables.

Course Contents

Presentation of Population and Demographic Data by Graphs and Charts, Computations of Population Change and Growth Rates, Analysis of Marital Status Distribution, Marriage and Divorce Rates, Computation of Different Measures of Fertility and Reproduction from Vital Registration and Census Data (such as CWR, CBR, ASFR, ASMFR, TFR, GFR, GRR, NRR and PPR), Computation of Different Measures of Mortality CDR, ASMR, IMR, Neonatal, Prenatal Death Rates, Standardization of Birth, Death, Marriage and Divorce Rates, Construction of Complete and Abridged Life Tables by different Methods, Computation of Migration Rates, Estimates of Migration by Survival Methods, Population Estimates and Projection using Mathematical Methods

Text Book

1. Barclay, J.: *Techniques of Population Analysis,* Wiley, New York.
2. Shryock, H. S., J. S. Siegel and Associates (2004): *The Methods and Materials of Demography;* Latest edition, Academic Press, N.Y.

Third Year
Second Semester

Course Title: Statistical Inference-II

Course Code	Stat-321	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course is designed to provide a strong mathematical and conceptual foundation in the methods of statistical inference. In the course theoretical foundations of the methods will be treated, their statistical properties will be studied and practical aspects for data analysis will be discussed.

Objectives

The objectives of this course are to-

- Acquire knowledge and insight in concepts of advanced statistical inference.
- Help students to draw better statistical inferences from empirical research.
- Teach students to construct and interpret confidence interval estimates of the parameters of different parametric models.
- Teach students to examine whether the null hypothesis is true using equivalence testing and Bayesian statistics.
- Acquaint/Equip students with a statistical tool kit which will enable them to apply their knowledge and skills to real life situations.

Learning Outcomes

Upon completion of this course, the students will be able to-

- Understand the definitions, the theoretical properties and the proofs that were given for the studied methodologies.
- Apply the general concepts and methodology to particular situations (e.g. investigate a new general concept for a particular estimator).
- Apply the methods and techniques in R and can understand and interpret the output to draw the correct conclusions.
- Judge the quality of estimators.
- Choose appropriate methods of inference to tackle real problems.
- Demonstrate computational skills to implement various statistical inferential approaches.
- Demonstrate the plausibility of pre-specified ideas about the parameters of the model by examining the area of hypothesis testing.

Course Contents

Classical Approach

Point Estimation: Minimum Variance Bound, Minimum Variance Unbiased Estimators, Uniformly Minimum Variance Unbiased Estimators, Ancillary Statistics, Minimal Sufficient Statistics, Minimax Estimator, Admissible Estimator, Selection of Conjugate Prior, Bhattacharyya Inequality, MRE Estimator, Shrinkage Estimator, James-Stein Estimator.

Interval Estimation: Confidence Intervals for Parameters of Binomial, Poisson, Normal Distribution and Exponential Distribution, Large Sample Confidence Interval, Neyman Classical Confidence Intervals.

Hypothesis Test: Neyman Pearson Lemma, Most powerful test, Uniformly Most Powerful Test, Uniformly Most Powerful Unbiased Test, Locally Uniformly Most Powerful Unbiased Test, Optimal Tests in Different Situations, Randomized Tests, Consistent Tests, Unbiased Tests, Similar Region.

Likelihood Ratio Test, Distribution of LR Statistic, Asymptotic distribution of LR Statistic, LR test in linear model, Generalized Likelihood Ratio Tests, Monotone Likelihood Ratio Test, LM Test and Wald Test.

Sequential Analysis, SPRT, Efficiency of SPRT, Fundamental Identity of Sequential Analysis, OC and ASN Function.

Bayesian Approach

Point Estimation: Concept of Bayesian Methods, Bayesian Approach to Estimation Theory, Prior and Posterior Distribution, Bayes Risk, Bayes Estimation, Posterior Bayes Estimator

Interval Estimation: Bayesian Interval Estimation, Credibility Interval

Hypothesis Testing: Bayesian Test of Hypothesis, Test of hypothesis concerning normal and exponential distribution in predictive approach. Bayesian treatment of linear model. Bayesian approach to contingency tables.

Text Books

1. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics*, 3rd edition, McGraw-Hill, New York.
2. Cassela, G. and Berger, R. L. (2001): *Statistical Inference*, Wadsworth Publishing Company, California.
3. Kendall, M. and Stuart, A. (1979): *The Advanced Theory of Statistics*, Volume 2, 4th edition, Macmillan Publishing Inc., New York.

Reference Books

1. Hogg, R.V. and Craig, A. T (2009): *Introduction to Mathematical Statistics*, 6th edition, Pearson Education, Singapore.
2. Kendall, M.G. and Stuart, A. (2004): *Advanced Theory of Statistics*, 14th edition, Edward Arnold, New York.
3. Lindley, D.V (1965): *Introduction to Probability and Statistics*, Part II.C.U.P, London.
4. Rao, C. R. (1984): *Linear Statistical Inference and its Applications*, 2nd edition, Wiley, New York.
5. Rohatgi, V. K. (1993): *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern.

Course Title: Order Statistics and Non-Parametric Methods

Course Code	Stat-322	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The aim of the course is to enable the student to work with order statistics, which is important in regard to the study of extreme value theory and advanced statistics. The course also aims at providing the basics of hypothesis testing with emphasis on some commonly encountered hypothesis tests in statistical data analysis.

Objectives

Objective of this course are to-

- Get familiar with distribution theory for order statistics.
- Give the competence to handle model building and/or model calculations
- Give skills to perform statistical analyses
- Give theoretical knowledge about and practical experience with the application of methods and models in statistics
- Give knowledge about the difference between parametric and non-parametric tests of hypothesis
- Get familiarize with some important and widely used non-parametric test
- Introduce the Criteria for choosing an appropriate non-parametric test

Learning Outcomes

After completion of this course students will be able to-

- Identify problems that can be solved using order statistics
- Describe the theoretical properties of order statistics
- Perform elementary probability calculations on order statistics
- use order statistics for parameter estimation
- Compare and contrast parametric and non-parametric tests of hypothesis
- Identify multiple applications where parametric or non-parametric approaches are appropriate
- Analysis appropriate hypothesis testing procedure based on type of outcome variable and number of samples in practical situations.
- Compare and contrast parametric and non-parametric tests of hypothesis
- Analysis appropriate hypothesis testing procedure based on type of outcome variable and number of samples in practical situations.

Course Contents

Order Statistics: Definition and distribution function of order statistics for both discrete and continuous case, asymptotic distribution, sample cumulative distribution function, joint distribution of n order statistics, marginal distribution of order statistics, conditional distributions of order statistics, distribution of median and range, exact moments of order statistics, large-sample approximations to mean and variance of rth order statistics, simple estimation of parameters based on order statistics, best linear unbiased estimation based on order statistics, estimation based on selected statistics.

Non-parametric Estimation: Estimation of moments, point and interval estimation of distribution function and density function with examples, point and interval estimation of percentiles, confidence interval for distribution function.

Non-parametric Test

Difference between parametric and non-parametric tests, concepts of distribution free test, distribution theory of runs, test based on total number of runs, test based on length of longest run, runs up and down, and randomness test based on ranks, distribution theory of Kolmogorov-Smirnov (K-S) one sample test statistic and test based on K-S test, comparison of Chi-Square test and Kolmogorov-Smirnov Test for goodness of fit, definition, correlation between variate values and ranks, treatment of ties in rank tests, and Kruskal-Wallis one-way Anova test.

One-Sample and paired-Sample Techniques: Sign test, Wilcoxon signed-rank test and their distributional properties.

General Two Sample Problem: Wald-Wolfowitz runs test, Kolmogorov-Smirnov two-sample test, median test and Mann-Whitney U test and their distribution under null hypothesis, confidence interval procedures, and linear rank statistics.

Linear Rank Test for Location and Scale Problem: Wilcoxon rank-sum test, and Mood test.

Text Book

1. Arnold B.C., Balakrishnan, N. and Nagaraja, H.N.: *First Course in Order Statistics,* Wilely New York.

Reference Books

1. Gibbons, J.D. and Chakraborti, S Gibbons, (1992): *Nonparametric Statistical Inference, Marcel Dekker,* Inc, USA.
2. Conover.W.J.: *Practical Non parametric Statistics,* Willey, New York.
3. David, H.A.: *Order Statistics,* 2ndEd, John Wiley, New York.

Course Title: Linear Programming and Operation Research

Course Code	Stat-323	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Linear programming (LP) and Operation Research is the fundamental modelling technique in optimal decision-making. The course will discuss theoretical aspects of linear programming, such as polyhedral theory, duality theory, optimality conditions, convexity, degeneracy, and convergence theory. This course will cover the simplex method in detail, emphasizing both mathematical foundations as well as computational considerations for effective computer implementations.

Objectives

The objective of this course is to-

- Introduce the concepts of Operation Research and LPmodeling.
- Explore the mathematical properties of general LP problems.
- Minimize or maximize a linear function subject to a system of linear inequality and/or equality constraints.
- Study the theory of the simplex algorithm as a solution technique.
- Setting up of transportation problem with its solution
- Have an idea of game theory.

Learning Outcomes

Students who successfully complete the course should-

- Identify decision variables, problem parameters, objectives, and constraints in practical optimization problems.
- Formulate a range of practical optimization problems as LP models, including problems in finance industry, network flow, supply chain management, healthcare, telecommunication, etc.
- Apply the Simplex method and other traditional techniques to solve LPs
- obtain the best decisions (according to a well–defined objective) in allocating scarce resources such as capital, materials, equipment, manpower, energy, etc
- Extend their existing theoretical and methodological knowledge in operations research.

Course Contents

Introduction: Definition, scope and limitations of operational research, problem formulation and modeling in operational research, classification of operational research and important characteristics of operational research techniques.

Linear Programming: Introduction, formulation of linear programming problem, hyper-plane, hyper-sphere, open set, closed set, convex set, convex polyhedron, convex and concave functions, basic solution, basic feasible solution, non-degenerate and degenerate basic solution, theorem related to solution, properties of solution to linear programming problem, graphical solution, generating extreme point solution, simplex methods, revised simplex method, Dual Simplex Method, Two-phase Method, Big-M method, introduction to transportation problem, setting up of transportation problem with its solutions, concept of non-linear programming.

Game Theory: "Two person zero sum" game and non-zero sum games, pure, mixed and optimal strategy games, solution of game by graphical methods, simplex method, approximate solution of game by brown's algorithm.

Text Book

1. Taha, H.A.: *Operation Research An Introduction*, Prentice-Hall New Delhi.
2. Gass, S.I (2010: *Linear Programming Methods and Applications*, 4th edition, Dover Publications/McGraw-Hill, New York.

Reference Books

1. Hadley,G (1990): *Linear Programming*, Oxford and IBH.
2. Swarup,KGupta,,P.K and Mohan, M (2003): *Operations Research*, Sultan Chand and Publications, New Delhi.
3. Saaty, T.L.: *Mathematical Methods of Operation Research*, McGraw-Hill, New York.
4. Sasieni, M. and Yaspan, A.: *Operation Research Methods and Problems*, Wiley, New York.

Course Title: Environmental Statistics

Course Code	Stat-324	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course is designed to introduce students to the basic statistical methods necessary to conduct and understand statistical analyses of environmental issues and problems.

Objectives

The objective of this course are to-

- Apply statistical methods to important problems in environmental sciences, with a focus on understanding and quantifying change in environmental sciences or problems of this nature.
- Provide intensive ideas of applying different statistical tools in the field of environmental sectors
- Teach the essential theory like deterministic and stochastic process, sampling techniques, dilution theory and statistical rollback alongside the practical components to analyze real environmental data.

Learning Outcomes

Upon successful completion of the course, students will be able to-

- Make sense of the statistical terms that appear in scientific papers and the media of environmental sectors.
- Summarize environmental data using graphs, tables, and numerical summaries
- Choose appropriate statistical methods to answer research questions
- Use statistical software to apply these methods, and interpret the output.

Course Contents

Introduction: Concept of environmental statistics, uses and importance of environmental statistics.

Environmental Pollution: Pollution and its importance, why does pollution happen? Pollutant sources, detail study of air and water pollution, global climate change and global warming.

Stochastic process in Environment: Applications of Bernoulli. Poisson and normal processes to environmental problems.

Environmental sampling: Network Sampling, composite sampling, ranked-set-sampling.

Detectability of Sampling: Basic Concept of Detectability, constant detectability over region, estimating detectability, effect of estimated detectability, detectability with simple random sampling. Diffusion and Dispersion of Pollutants: Wedge Machine, Particle Frame machine, Plume model.

Dilution of Pollutants: Deterministic dilution, stochastic dilution. Theory of successive random dilution (SRD), application of SRD to Environmental phenomena: Air quality, indoor air quality, water quality, concentrations of pollutants in soils, plants and animals. Concentration in food and human tissue.

Statistical Theory of Rollback: Predicting concentrations after source control, correlation, previous rollback concepts, environmental transport models in air and water.

Spatial Methods for Environmental process: Spatial Point Process Models and methods, General Spatial Process, More about Spatial Models, and Spatial Sampling and Spatial Design.

Text Book

1. Barnett, V. and Turkman, K.F (1993): *Statistics for the Environment*, John Wiley and Sons, Chichester.

Reference Books

1. Bryan, F. J.: *Statistics for Environment Science and Management*, 1st Ed. CRC Press.
2. Wayner .R. Ott,(2002): *Environmental Statistics and Data analysis*, Lewis Publishers, England.

Course Title: Research Methodology

Course Code	Stat-325	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The course research methodology is designed to make the students objective identification, collection, analysis, dissemination and use of information for the purpose of improving decision making related to the identification and solution of problems and opportunities in different sectors.

Objectives

The objectives of research methodology are to-

- Know the basic concepts of research.
- Know the types of research.
- Write a research proposal.
- Know the uses of research data.
- Operate the analysis of data.
- Know the evaluation of research.
- Prepare the report and present the report.

Learning Outcomes

At the end of this course students will able to-

- Have foundation and philosophy of research.
- Identify the problems for research.
- Write the research proposal.
- Measure the scaling of research data.
- Analyze the research data and presentation of research.
- Complete a dissertation and writing a report.
- Evaluate the research.

Course Contents

Introductions: Definitions,Why is Research Conducted? How Research Conducted? Classification of Research, Research Process, Role of Research in Decision Making, Ethics in Research.

Formulation of Research Design: Definition of Research Design, Classification of research Design and their Relations, The Research Cycle, Problems with the research Process, Structure of Research.

Exploratory Research Design (Secondary Data): Advantage and uses of secondary data, Disadvantages of secondary data, Evaluating of secondary data, Classification of secondary data.

Exploratory Research Design (Qualitative Research): Rationale for using qualitative research, Classification of qualitative research procedure, Focus Group Discussion (FGD), Depth Interviews, Projective Techniques.

Causal Research Design: Concept of causality, Conditions for causality, Definitions of symbols, Extraneous variables, and Classification of experimental design.

Measurement and Scaling: Construct Validity, Measurement Validity Types, Idea of Construct, Validity, Convergent & Discriminant Validity, Threats to Construct Validity, The Nomo logical Network, The Multitrait-Multimethod Matrix, Pattern Matching for Construct Validity, General Issues in Scaling, Thurston Scaling, Likert Scaling, Guttmann Scaling.

Questionnaire and Form Design: Questionnaire and Observation Forms, Questionnaire Design Process, Type of Interviewing Method, Individual Question Content, Form and Layout, Pretesting, and Computer and Internet Questionnaire Construction.

Evaluation Research: Introduction to Evaluation, The Planning-Evaluation Cycle, An Evaluation Culture.

Sampling: External Validity, Sampling Terminology, Statistical Terms in Sampling, Probability Sampling, Nonprobability Sampling, and Sample Size determination.

Reliability: True Score Theory, Measurement Error, Theory of Reliability, Types of Reliability, Reliability & Validity, Levels of Measurement.

Survey Research: Types of Surveys, Selecting the Survey Method, Constructing the Survey, Types of Questions, Question Content, Response Format, Question Wording, Question Placement, Interviews, Plus & Minus of Survey Methods.

Data: Data collection, Preparation, Analysis and Reporting.

Report Preparation and presentation: Importance of the Report and Presentation, The Report Preparation and Presentation Process, Report Preparation, Report Format, Report Writing, Research Follow-Up.

Text Book

1. Malhotra, N. K. (2006): *Marketing Research*, 4th Ed, Pearson Education, Singapore.

Reference Books

1. Kothari,C R. : *Research Methodology -.Methods and Techniques*. 2nd Edition, New Age Publications, India.
2. Islam, M.N. : *An introduction to Research Methods*. Book world
3. Zikmund, W. G. (2009). *Business Research Methods*, 7th edition, South-Western Pub.

Course Title: Statistical Data Analysis- VI

Course Code	Stat-326	Course Credit	03	Number of Class	35-40	Full Marks	100

Group A (Linear Programming and Operation Research): 35 Marks

Rationale

This course aims at familiarizing the students with quantitative tools and techniques, whichare frequently applied to business decision-making & to provide a formal quantitative approach to problem solving and an intuition about situations where such an approach is appropriate.

Objectives

The objectives of this course are-

1. To introduce the students how to use variables for formulating complex mathematical models
2. To provide the students with opportunity of using various software package for solving linear programming models
3. To introduce the students to the use of basic methodology for the solution of linear programs
4. To use concepts from game theory to construct model for competitive real world phenomena.

Learning Outcomes

At the end of this course students will able to-

- Identify and develop operational research models from the verbal description of the real system.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.
- select an optimum solution with profit maximization
- Model competitive real world phenomena using concepts from game theory
- propose the best strategy using decision making methods under uncertainty and game theory
- Possess a set of intermediate level game-theoretic skillistics which can be applied in real world contexts.

Course Contents

Solution of linear programming problems by graphical method, geometric, simplex methods, revised simplex method, Dual Simplex Method, Two-phase Method, Big-M method, problems on transportation problem, Solution of "Two person zero sum" game and non-zero sum games, pure, mixed and optimal strategy games, solution of game by graphical methods, simplex method, approximate solution of game by Brown's algorithm.

Text Book

1. Taha, H.A.: *Operation Research An Introduction,* Prentice-Hall New Delhi.
2. Gass, S.I (2010: *Linear Programming Methods and Applications,* 4th edition, Dover Publications/McGraw-Hill, New York.

Group B (Order Statistics and Non-parametric Methods):35 Marks

Rationale

This course aims at introducing order statistics and the "modern" nonparametric techniques in statistical analysis and the use of these techniques in a variety of disciplines

Objectives

The objective of this course are to-

- Learn the formal definition of order statistics
- Determine the moments of the rth order statistic from the practical data.
- Derive the probability density function of the rth order statistic.
- Derive a method for finding the (100p)th percentile and confidence interval of the sample.
- acquaint students with the basic ideas, applicability, and methods of nonparametric data analysis

Learning Outcomes

At the end of this course students will able to-

- Find the moments of rth order statistics from the sample
- Find probability density function of the rth order statistic
- Calculate percentile and confidence interval of the sample
- Compare and contrast parametric and nonparametric tests
- Perform and interpret the Mann Whitney U Test, Sign test Wilcoxon Signed Rank Test, Kruskal Wallis
- Compare and contrast the Sign test and Wilcoxon Signed Rank Test.
- Identify the appropriate nonparametric hypothesis testing procedure based on type of outcome variable and number of samples.

Course Contents

Estimation of moments, point and interval estimation of distribution function and density function, point and interval estimation of percentiles, confidence interval for distribution function.

Randomness test based on ranks, Kolmogorov-Smirnov (K-S) test, Chi-Square test, Sign test, Wilcoxon signed-rank test, binomial and quantile test, Kolmogorov-Smirnov two-sample test, median test and Mann-Whitney U test, Wilcoxon rank-sum test, terry hoeffding test, Van Der Waerden test, test for different location and scale problems.

Text Book

1. Arnold B.C., Balakrishnan, N. and Nagaraja, H.N.: *First Course in Order Statistics,* Wilely New York.
2. Gibbons, J.D. and Chakraborti, S Gibbons, (1992): *Nonparametric Statistical Inference, Marcel Dekker,* Inc, USA.

Group C (Statistical Inference-II): 30 Marks

Rationale

The aim of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical inference, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in statistical research.

Objectives

The objective of this course are to-

- Estimate the point and interval for parameter.
- Estimate the parameters by Bayesian approach.
- Test the hypothesis concerning and exponential distribution.
- Develop LR test, GLR test, MLR test.

Learning Outcomes

After completing this part students will be able to:

- Estimate the Bayes' Statistics.
- Find out the point and interval estimation.
- Test the different testing approach such as (LR, GLR, and MLR test).

Course Contents

Most powerful test, Uniformly Most Powerful Test, Uniformly Most Powerful Unbiased Test, Locally Uniformly Most Powerful Unbiased Test, Optimal Tests in Different Situations, Randomized Tests, Consistent Tests, Unbiased Tests, Similar Region, Likelihood Ratio Test, Generalized Likelihood Ratio Tests, Monotone Likelihood Ratio Test, Test of homogeneity in Parallel Samples., LM Test and Wald Test, SPRT, OC and ASN Function, Bayesian Test of Hypothesis.

Text Book

1. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics,* 3rd edition, McGraw-Hill, New York.
2. Cassela, G. and Berger, R. L. (2001): *Statistical Inference,* Wadsworth Publishing Company, California

Course Title: Viva-Voce

Marks	50	Credits	02

Fourth Year
First Semester

Course Title: Multivariate Analysis

Course Code	Stat-411	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The purpose of the course is to introduce modern methods of multivariate analysis, their application on real-life data, and proper interpretation of the obtained results. In the process, students also learn how to use the latest software tools for multivariate analysis.

Objectives

The main aim of the course is to-

- Understand and explain what multivariate statistical analysis is and when its application is appropriate and derive various statistics for random vectors via matrix algebra.
- Graphically display multivariate data.
- Demonstrate thorough familiarity with multivariate distributions, and in particular multivariate normal and Wishart distributions.
- Demonstrate knowledge in drawing inferences about mean vectors and comparison of several multivariate means.
- Develop and analyze multivariate regression models.
- Condense information contained in a large number of variables into a smaller set of factors using principle component and factor analysis.
- Search for distinguishable groups of objects using various classification techniques.
- Implement all of the above using standard statistical packages (e.g., R, SPSS, STATA).
- Reproduce the results obtained in statistical packages (e g., R, SPSS, STATA) using spreadsheets (e.g., Excel)

Learning Outcomes

By the end of the course, students should be able to-

- Perform exploratory analysis of multivariate data, such as plot multivariate data, calculating descriptive statistics, testing for multivariate normality;
- Conduct statistical inference about multivariate means including hypothesis testing, confidence ellipsoid calculation and different types of confidence intervals estimation;
- Undertake statistical analyses using appropriate multivariate techniques, which include principal component, factor analysis, discriminant and clustering analysis.

Course Contents

Introduction: Concept of multivariate data, examples from real life and uses of multivariate analysis.

Multivariate Normal Distribution: Meaning, derivation and properties of normal distribution, multivariate determining probability density contour, maximum likelihood estimator of mean vector and variance covariance matrix. Evaluating normality of univariate and multivariate normal distribution and normal distribution by P-P and Q-Q plot, steps in detecting outliers and cleaning data, transformation to near normality by square root, logit, fisher's and box-cox transformation. Mahalnobis D2.

Multivariate Sampling Distributions: Hotelling's T2 and its properties, Wishart distribution and its Properties.

Principal Components: Introduction to the principalcomponents analysis. ML estimator of the principal components and their variances. Sampling properties of the Sample principal components. Statistical inference.

Factor Analysis: Definition and purpose of factor analysis, the mathematical model for factor structure. ML estimators for random orthogonal factors. Estimation for fixed factors. Testing the goodness of Fit of the factor model. Factor interpretation and transformation.

Discriminant Analysis: Meaning and goals of Discriminantions and Classification, Fisher's linear discriminant function, Classification into one of two and into one of more than two multivariate populations. Quadratic discriminators. Test of a discriminant function.

Text Books

1. Johnson, R.A. & Wichern, D.W. (2007): *Applied Multivariate Statistical Analysis, Prentice* –Hall Inc.
2. Anderson, T. W. (1984), *Introduction to Multivariate Analysis*, 2nd edition, 1984, John Wiley, New York.

Reference Books

1. Kendell. M.G.: *Multivariate Analysis*, New York,
2. Kshiragar, A.M: *Multivariate Analysis*, MarcellDekkarInc .New York.

Course Title: Sampling Technique-II

Course Code	Stat-412	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

The main reason of Sample survey course is to provide an overview of basic sampling and estimation methods.

Objectives

The main objective of this course is to-

- Demonstrate knowledge and understanding of the basic methods in common use for sampling from finite populations, including the most common sampling designs,
- How to estimate finite population parameters and how to assess the estimation errors.
- Compare the efficiencies of different methods.

Learning Outcomes

After completing this course a student will able to-

- Design survey using different sampling strategy, calculating estimate and assessing precision of estimator.
- Conduct survey using cluster sampling of unequal size and varying probability
- Assess relative efficiency of cluster sampling compare with other sampling schemes
- Conduct two stage and multistage cluster sampling and obtains estimator with great precision.
- Design double sampling procedures (stratified sampling, ratio estimator, regression estimator, product, PPS) and repetitive surveys (Multiphase sampling)
- Understand meaning of non-response error, characteristics of non-response error and also remedial measures of non-response error
- Perform estimation procedure in the presence of non-response error.

Course Contents

Sampling Strategy: Equal and unequal Probability Sampling with and without replacement. Different sampling schemes, Horvitz-Thompson estimator, probability proportional to size sampling Brewers, Durbin, Raj, Murthy, Rao and Cochran's methods, comparisons of their efficiencies.

Cluster Sampling: Unequal size and varying probability cluster sampling, Relative Efficiency, Determination of optimum cluster size, Relative Accuracy's, Sub-sampling with units of Equal and Unequal sizes Two stage, Three stage and Multistage sampling. Optimum sampling and sub-sampling fractions, two stage and Three stage pps sampling, Self weighting sampling.

Double Sampling Procedures and Repetitive Surveys: Introduction, Double sampling for Stratification, Ratio, Difference, Regression, Product and PPS estimation, Optimum allocation, Sampling on Two or more occasions, Repetitive surveys, Multi phase sampling.

Non-Response: Introduction, characteristics of non-response, measuring non-response, dealing with non-response, perspectives on non-response, estimation in presence of unit non-response, methods of reducing non-response and response errors.

Text Books

1. Cochran, W. G. (1977): *Sampling Techniques*, 3rd edition, Wiley, New York.
2. Raj, D. and Chandhok, P. (1998): *Sample Survey Theory*, Narosa Publishing House, New Delhi.

Reference Books

1. Islam, M. N.: *An Introduction of Sampling Methods: Theory and Applications*.
2. Murthy, M.N. (1977): *Sampling Methods*, 2nd edition, Statistical Publishing Society, Calcutta.
3. Sing, D: *Theory of Analysis of Sample Survey Design*, New Age Publisher.
4. Thompson, S. K(2002), *Sampling*, John Wiley, New York.

Course Title: Mathematical Demography

Course Code	Stat-413	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Mathematical demography focuses on population phenomena and their relations with other population phenomena. This also reviews some of the latest developments in the large body of mathematical theory concerned with the growth processes of populations.

Objectives

The main objective of this course are-

- Describe basic demographic indicators and elaborate on their computation and interpretation.
- Introduced Age-sex composition structure and Age heaping evaluation
- Discuss the Dual Record System, Chandra Sekhar-Deming Formula, Evaluation and Adjustment of Demographic Data.
- Introduce population projection calculations and analysis.
- Describe the distribution of a population using various demographic characteristics.
- Construct and analyze simple and multiple decrement life tables.
- Describe the relations and calculate indicators in a stationary population and stable populations.
- Estimate the rate of change in a population
- Construct a Lexis diagram.
- Demonstrate the different concepts of Microdemography like fecundity, fecundability and sterility.

Learning Outcomes

By the end of the course students should be able to-

- Construct a life and determine the life expectancy
- Calculate a stable population, compute and analyze the basic features and measures of the associated population dynamics;
- Carry out basic operations on matrices and vectors, and apply basic matrix algebra to population projection problems
- Appreciate specific issues in population projections, such as small area, household and multistate projections
- Demonstrate problem solving by using spreadsheets and open access demographic software for a range of demographic tasks.

Course Contents

Age-Sex Composition: Age-Sex Composition and Structure, Statistics on Age, Age Heaping Evaluation of Age and Sex Data, Myer's Index, Whipple's Index, United Nation Index, Causes of Errors in Age Data and their Detection, Population Pyramid, Cohort and Lexis Diagram.

Dual Record System and Fertility Models: Dual Record System, Chandra Sekhar-Deming Formula, Evaluation and Adjustment of Demographic Data. Fertility Models (Coale-Trussell, Gompertz Relational), Proximate Determinants of Fertility.

Life Table Functions: Life Table Functions, Properties and Interrelationships, Sampling Distribution of Life Table Functions, Estimation of Survival Probability, Multiple Decrement Life Table, Increment-Decrement Life Tables, Model Life Tables.

Stable Population Model: Lotka and Dublin's Model, Intrinsic Age Distribution, Lotka's Integral Equation and its Complex Roots, Relationship Between the Mean Length of Generation and age of Childbearing, Graduation of the Net Marternity Function-Lokta, Wicksell and Hadwiger, Interrelationship of Demographic Variables in Stable Population, Quasi Stable Population, Comparison of the age Distribution of a Stable Population with that of Quasi Stable Population.

Microdemography: Fecundity, Fecundability and Sterility, Effective Fecundability, Residual Fecundability Estimation of Measures of Fecundability Pearl Index, Effectiveness and Efficiency of FP Method. Population Projection. Population Projection in Matrix Notation (Lasli Matrix)

Text Books

1. Rogers, A (1966): *Introduction to Multiregional Mathematical Demography.* Wiley Intersciesce, NW

Reference Books

1. Bogue, D.J. (1969): *Principles of Demography,* Wiles & Sons. NW
2. Biswas, S. (1988): *Stochastic Processes to demography & Application,* Wiley Eastern Ltd. Delhi.
3. Shyrock, H.S. & Siegel J.S. (1973): *The Methods and Materials of Demography.* Vol 1 & 2: Bureau of Census, Washington.

Course Title: Statistical Simulation

Course Code	Stat-414	Course Credit	02	Number of Class	20-26	Full Marks	50

Rationale

Statistical analysis of real world systems and models will typically require computer intensive methods. The course starts with a study of modern Monte Carlo methods, including Markov chain Monte Carlo, and variance reduction methods.

Objectives

The objectives of this course is to-

- Making students familiar with the most important elements of the Monte Carlo method
- Explain and demonstrate techniques for the generation of random numbers with normal, Poisson and other distributions.
- Define basic concepts in modeling and simulation
- Demonstrate the use of random number sets for simulation of data with a random error and for Monte-Carlo methods for integration and simulations.

Learning Outcomes

After successful completion of this course students will be able to-

- Model and simulate basic statistical problems
- Generate random numbers from different distributions
- Collect, analyze and present numerical data in general and simulation results in particular.
- Classify various simulation models and give practical examples for each category
- Construct a model for a given set of data and motivate its validity

Course Contents

Overview: Meaning, Simulation Process, Verification, Validation, Synchronous and Asynchronous Discrete Event Simulation, Continuous Event Simulation, Hybrid Event Simulation, Monte Carlo: Hit or Miss Monte Carlo Method, Sample- Mean Monte Carlo Method.

Generating Discrete Random variables: The Inverse Transform method, Generating Poisson Random variable, Generating Binomial Random variables, The Acceptance-Rejection Technique, The Composition Approach, and Generating Random vectors.

Generating Continuous Random variable: The Inverse Transform Algorithm, The Rejection Method, The Polar Method for Generating Normal Random Variables, and Generating a Poisson Process.

Discrete Event Simulation Approach: Simulation via Discrete Events, A Single-Server Queuing System, A Queueing System with Two Servers in Series, A Queueing System with Two Parallel Servers, An Inventory Model.

Variance Reduction Technique: Stratified Sampling, Conditional Monte Carlo, Jackknifing, Antithetic Variates.

Generating Uniform Random Variable: Classes of Generators – Random Devices, Tables, Midsquare Method, Fibonacci and Additive Congruential Generators, Linear Congruential Generators, Linear Recursion Mod 2 Generator, Combinations of Generators, Choosing Good Generator Based on Theoretical Considerations, Serial Correlation, Cycle of Length, Spectral Test.

Generating Non-Uniform Random Variables: Alias Method, Inverse Transformation Method, Acceptance-Rejection Method, Polar Method, Method of Generating Random Numbers from Normal, Exponential, Gamma, Beta, Cauchy, Binomial, Poisson, Geometric, Negative Binomial Distributions t, F and x^2.

Markov Chain Monte Carlo Methods: Markov Chain, The Hasting-Metropolis Algorithm, The Gibbs Sampler.

Text Books

1. Bartley, P., Fox, B. L. and Schrage, L. E. (1987): *A Guide to Simulation,* 2nd Edition, Springer-Verlag, New York.

Reference Books

1. Averil M. Law (2010): *Simulation Modeling and Analysis,* 4th Edition, Tata McGraw-Hill Education Private Limited, New Delhi
2. Rubinstein, R. Y. and Kroese, D. P. (2007): *Simulation and the Monte Carlo Method,* 2nd Edition, John Wiley and Sons, New York.

Course Title: Epidemiology

Course Code	Stat-415	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Epidemiology will accustom the students with the origin and causes of diseases in a community. It is the scientific method of investigation problem-solving used by disease detectives. This course will offers powerful tools to quantify the degree to which risk factors and humanitarian interventions affect population health in a crisis.

Objectives

This course is structured for students to-

- Get accustomed with epidemiologic terminology, outcome measures, and study designs;
- Combine appropriate epidemiological concepts and statistical methods.
- Distinguish the roles and relationships between epidemiology and biostatistics in the prevention of disease and the improvement of health
- Compute basic descriptive statistics and explore data analytic methods.

Learning Outcomes

After completion of this course students will be able to-

- Understand the criteria commonly used to evaluate causal relationships.
- Understand and Critique the study design and quantitative methods used in published literature and appropriately interpret the findings.
- Understand and calculate commonly used health measures, such as relative risk, attributable risk, and odds ratio; select appropriate methods for estimating such measures.
- Interpret descriptive and inferential statistics resulting from data analysis and draw relevant conclusions.
- Apply the concepts of confounding and bias to describe variables
- Identify key sources of epidemiologic data.
- Formulate and apply epidemiologic methodology to identify a specific public health problem, develop a hypothesis, and design a study to investigate the issue.

Course Contents

Introduction: Definition and scope of epidemiology, uses of epidemiology, Descriptive Epidemiology, Concept of cause, establishing cause of disease.

Types of Epidemiologic Studies: Cross Sectional, cohort, case control, retrospective and prospective, clinical trials, community intervention and cluster randomized trials.

Measures of Disease Frequency: Incidence and prevalence rates, relation between incidence and prevalence, case fatality rate, risk ratio, rate ratio, risk difference, rate difference, mortality measures, standardized mortality ratio.

Measures of association: Relative risk, attributable risk, odds ratio, risk difference, comparison of proportion different sample.

Epidemiology and Prevention: Scope of prevention, levels of prevention: primordial, primary, secondary and tertiary.

Screening: Sensitivity, specificity, negative and positive predictive values.

Confounding and Interaction: Confounding, interactions, methods for assessment of effect modification; Strategies to allow/adjust for confounding in design and analysis.

Text Books

1. Kenneth, J. and Rothman, S. G. (2008): *Modern Epidemiology,* 3rd Ed, Lippincott Williams and Wilkins, USA.

Reference Books

1. Kleinbaum, .G, Kupper L. L and Morgenstern (1982): *Epidemiologic Research.*
2. Mark Woodward: *Epidemiology, Study design and data analysis.*

Course Title: Actuarial Statistics

Course Code	Stat-416	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course will focus not only on quantitative aspects but also on management aspect. The program intends to train personnel to work in Insurance firms, Pension departments of various organizations, Banks and other Financial Institutions in the national and international arena.

Objectives

The main objectives of this course is to-

- Provide an understanding of the fundamental concepts of financial mathematics, and how these concepts are applied in calculating present and accumulated values for various streams of cash flows.
- Introduce financial instruments, such as derivatives, the concept of no-arbitrage.
- Provide a solid grounding in the subject of life contingencies for single life, and in the subject of the analysis of life assurance and life annuities, including pension contracts.
- Provide an introduction to mathematical methods for managing the risk in life insurance.
- Develop skills of calculating the premium for a certain life insurance contract, including allowance for expenses and profits.

Learning Outcomes

After the successful completion of the course students will be able to-

- Understand and calculate all kind of rates of interest, find the future value and present value of a cash flow.
- Derive formulae for all kinds of annuities.
- Given an annuity with level payments, immediate (or due) , payable monthly, (or payable continuously), and any three of present value, future value, interest rate, payment, and term of annuity, calculate the remaining two items.
- Given an annuity with non-level payments, immediate (or due) , payable monthly, (or payable continuously), the pattern of payment amounts, and any three of present value, future value, interest rate, payment, and term of annuity, calculate the remaining two items.
- Calculate the outstanding balance at any point in time.
- Calculate a schedule of repayments under a loan and identify the interest and capital components in a given payment.
- Calculate the present value of payments from a fixed interest security, bounds for the present value of a redeemable fixed interest security.
- Given the price, calculate the running yield and redemption yield from a fixed interest security.
- Explain and analyze the factors that affect mortality, simple life assurance and life annuity contracts.
- Understand the concept (and the mathematical assumptions) of the future life time random variables in continuous and discrete time.
- Define and calculate the different types of the survival probabilities in theoretical and numerical examples.
- Understand the concept of the life table and how to use it in life insurance; life annuities, pension plans, expense function and dividends.

Course Contents

The meaning of actuarial science, its relationship with life insurance, role of insurance in the economy, important uses of actuarial statistics specially in context of Bangladesh.

Theory of rates of interest and discount including theoretical continuous case of forces of interest and discount, annuities and sinking funds including continuous case, practical and theoretical applications primarily to mortgages and bonds, yield rates.

Economics of insurance, utility theory, application of probability to problems of life and death, determination of single premium for insurances and annuities in both discrete and continuous case.

Theory and practice of pension plan funding, assumptions, basic actuarial functions, population theory applied to private pensions.

Survival distributions, life table, life insurance, life annuities, net premium, premium series, multiple life functions, multiple decrement models, valuation theory for pension plans, expense function and dividends.

Text Books

1. Parmenter,M.M.: *Theory of Interest and Life contingencies with pension Application.*

Reference Books

1. Bowers, N.L., Gerber, H.V., Hickman, J.C., Jones, D.A. and Nesbitt, C. J.: *Actuarial Mathematics.*
2. Uddin, Mohammad Sohrab: *An Introduction to Actuarial and Financial Mathematics.*

Course Title: Statistical Data Analysis- VII

Course Code	Stat-417	Course Credit	03	Number of Class	35-40	Full Marks	100

Group A (Multivariate Analysis): 50 Marks

Rationale

This course focuses on the standard methods of multivariate statistical analysis. Many essential data analysis techniques, such as principal component analysis and discriminant analysis.

Objectives

The objectives of this course are to-

- Understand the main features of multivariate data.
- Use exploratory and confirmatory multivariate statistical methods properly.
- Carry out multivariate statistical techniques and methods efficiently and effectively.

Learning Outcomes

- Analyze multivariate data and the dependence structure of variates to extract the useful information from a massive dataset;
- Apply suitable tools for exploratory data analysis, dimension reduction, and classification to formulate and solve real-life problems;
- Implement the multivariate analysis techniques with statistical software such as R in amanner that the methodology adopted is motivated by appropriate statistical theory.

Course Contents

Assessing multivariate normality, Box-Cox Transformation, Test for a mean vector, Test for equality of Mean vectors, problems related on discrimination analysis, Principal component analysis, Factor Analysis.

Text Books

1. Johnson, R.A. &Wichern,D.W. (2007): *Applied Multivariate Statistical Analysis*, Prentice –Hall Inc.

Group B (Statistical Simulation): 50 MarksGroup B(Statistical Simulation): 50 Marks

Rationale

Rationale of this course is to generate random number from different discrete and continuous distribution by using different Monte-Carlo Methods.

Objectives

The objectives of this course is to-

- Use different Monte-Carlo Methods and computer program to generate random numbers from various distributions.
- Practice different parametric, non-parametric tests and graphical methods for testing Uniform Random Numbers.

Learning Outcomes

After successful completion of this course students will be able to-

- Generate random number from Uniform, Binomial, Poisson, Normal, Exponential, and Gamma Distribution by Different Monte-Carlo Methods
- Test random number variates and apply them to develop simulation models.

Course Contents

Generating Random Number from Uniform, Binomial, Poisson, Normal, Exponential, and Gamma and Weibull Distribution by Different Monte-Carlo Methods and Using Standard Softwares and Computer Program; Testing Uniform Random Numbers using Chi-Square Test, Kolmogorov-Smirnov Test and Graphical Methods, Assess Different Statistical Properties of Generated Data, Integration by Monte-Carlo Simulation.

Text Books

1. Bartley, P., Fox, B. L. and Schrage, L. E. (1987): A Guide to Simulation, 2nd Edition, Springer-Verlag, New York.

Course Title: Statistical Data Analysis- VIII

Course Code	Stat-418	Course Credit	03	Number of Class	35-40	Full Marks	100

Group A (Sampling Technique-II): 50 Marks

Rationale

The course is design to inspect the practical approach to inspect the design of a sample and estimation method about real life phenomena.

Objectives

The objectives of the course is to-

- Draw appropriate sampling for appropriate sample.
- Allocate the sample sizes for optimum cost and variance function for different sampling procedures.

Learning Outcomes

After completion of this course, the student will be able to-

- Design double sampling procedures (stratified sampling, ratio estimator, regression estimator, product, PPS) and repetitive surveys (Multiphase sampling) using appropriate software.
- Understand meaning of non-response error, characteristics of non-response error and also remedial measures of non-response error by using different software.
- Perform estimation procedure in the presence of non-response error using appropriate software.

Course Contents

Drawing probability sample, sample with and without replacement, estimation of population characteristics and variance of estimators for cluster sampling, double sampling, two stage sampling, Allocation of sample sizes for optimum cost and variance function for different sampling procedures.

Text Books

1. Cochran, W. G. (1977): *Sampling Techniques,* 3rd edition, Wiley, New York.
2. Murthy, M.N. (1977): *Sampling Methods,* 2nd edition, Statistical Publishing Society, Calcutta.

Group B (Mathematical Demography): 50 Marks

Rationale

This course introduces the basic techniques of demographic analysis. Students will become familiar with the sources of data available for demographic research. Population composition and change measures will be presented. Life table, standardization and population projection techniques will also be explored.

Objectives

The objectives of this course is to-

- Identify appropriate sources of data, perform basic demographic analyses using various techniques and ensure their comparability across populations.
- Produce population projections and interpret the information gathered by the different demographic methods.

Learning Outcomes

After completion of this course, the student will be able to-

- Perform basic demographic analyses using various techniques.
- Project the population by using different demographic methods.
- Construct life table and migration rate using different methods.

Course Contents

Estimation of Completeness of Birth and Death Registration. Calculation of Whipples's Index, Myer's Index. Smoothing of Age Data. Estimation of Intrinsic Birth Rate, Death Rate, Growth Rate and Stable Age Distribution, Construction Multiple Decrement Life Table. Estimation of Fertility Schedule Using Coale-Trussel Fertility Model and Gompertz Relational Model. Estimation of Fertility Using P/F Ratio Method. Estimating Child Mortality From Information on Children Ever Barn and Children Surviving. Estimation of Adult Mortality Using Orphan hood Data, Widowhood Data and from information on the distribution of Deaths by Age. Population Projection. Fitting of Logistic Curves by Different Technique.

Text Books

1. Rogers, A (1966): *Introduction to Multiregional Mathematical Demography.* Wiley Intersciesce, NW

Fourth Year
Second Semester

Course Title: Design of Experiment-II

Course Code	Stat-421	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

This course is designed to make the students oriented with most applied experimental designs to be used in different field at advanced level.

Objectives

Objectives of this course are to-

- Give students a sound understanding of different experimental design, both theoretical and practical. • Able students to learn the experimental designs most widely used in practice.
- Help students to choose an appropriate experimental design based on the study objectives.
- Teach students how to construct and implement the design selected.
- Help students to analyze the data collected based on the design used and its underlying assumptions.
- Able students to interpret the results of the experiment and report the conclusions.

Learning Outcomes

By the end of this course students will be able to-

- Describe the concepts of experimental design, determine the design used in a particular practical situation, and identify the factors relevant to the situation.
- Choose appropriate experimental design techniques in context of the problem.
- Identify, analyze and report on a selection of advanced experimental designs.
- Interpret the results and computer output from all of the above designs and present clear, orderly and informative statistical summaries and technical reports.
- Perform formal statistical analysis of data from a variety of disciplines.
- Build and apply experimental designs for the real-world problems.

Course Contents

Factorial and Split Plot Design: Factorial experiment up to pn series, asymmetrical factorial experiments, confounding, partial confounding, total confounding, balanced confounding, fractional replications, multiple comparison test, split-plot design.

Incomplete Block Design: Balanced incomplete block and partially balanced incomplete block design with their construction.

Covariance Analysis: Covariance Analysis, Covariance Analysis with One and Two Concomitant Variable, Analysis of Covariance in One-Way and Two-Way Classified Data.

Nested Design: Nested Design, Analysis of Two Stage Nested Design, Analysis of Three Stage Nested Design.

Text Book

1. Montgomery D. C. (2005): *Design and Analysis of Experiments*, 6th edition, Wiley, USA.

Reference Books

1. Cochran, W.G. and Cox, G.M. (2000): *Experimental Design*, 2nd Edition, Wiley, New York.
2. Das, M. N. and N. C. Giri (1986): *Design and Analysis of Experiments*, 2nd Edition, Wiley Eastern, India.
3. Fisher, R.A. (1995): *The Design of Experiments*, 8th edition, Hafner, New York.
4. Hitson, A. (1995): *The Analysis of Variance*, 3rd edition, Wiley, New York.
5. John and Quenouille (1977): *Experiments Design and Analysis*, 2nd Edition, Charles Griffin, London.

Course Title: Biostatistics

Course Code	Stat-422	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Biostatisticians will be trained in the skilled application of statistical methods to the solution of problems encountered in public health and medicine. Students with the statistical background, undertaking this course will further enhance their understanding of health issues and the application of statistics.

Objectives

This course is structured for students to-

- Know the basic concepts of Biostatistics
- Get a clear idea about survival data and related lifetime distribution
- Learn to get information from incomplete data or censoring mechanism
- Compare the efficiency of different survival curves.
- Develop statistical models, specified for health related data
- Learn to analyse and interpret real life survival data using statistical softwares.

Learning Outcomes

After completion of this course students will be able to-

- Apply basic statistical concepts commonly used in Health and Medical Sciences
- Apply descriptive techniques commonly used to summarize public health data.
- Interpret results of statistical analyses found in public health studies.
- Build statistical model over real health data.
- Estimate and compare efficiency of models..
- Use statistical software to analyze health –related data.

Course Contents

Lifetime Distributions: Survival Data, Probability density function, hazard function, survival function and their interrelationship, mean residual life function and median lifetime, some important lifetime distributions.

Incomplete data analysis: Types of censoring. Construction of likelihood function with censored data. Estimation of life parameters and their sampling variances from Exponential, Weibull, and extreme value distributions using type I and type II censored data.

Non-parametric Methods: Estimation of hazard and survival functions, actuarial and product-limit methods, standard errors, median survival time, tests, confidence intervals.

Parametric Survival Distributions: Likelihood function of failure time data for different censoring mechanisms with exponential, two parameter exponential, Weibull, lognormal, normal and gamma distributions, inference procedures (Estimation and tests for small and large samples).

Comparison of Survival Curves: Comparison of Two Groups, Log-rank (Mantel-Haenszel) Test; Hazard ratios, confidence interval for hazard ratios, stratified log rank test, median survival, non-proportional hazards, other tests for comparing two groups, comparison of more than two groups.

Logistic Regression Model: Introduction to logistic regression, important special cases of logistic regression model, computing the odds ratio in logistic regression, maximum likelihood estimation statistical inferences ,modeling strategy for assessing interaction and confounding, analysis of matched data, logistic regression for care control data, polytomous logistic regression model.

Text Book

1. Kleinbaum, D.G. (1996): *Survival Analysis,Springer,* New York.
2. Lawless, J.F.(2003): *Statistical Models and Methodsfor Lifetime data,* 2nd Ed, Wiley , New York

Reference Books

1. Cox, D.R and Oakes, D.(1988): *Analysis of Survival data,* Chapman and hall
2. Daniel W.W: *Bio-statistics: A Foundation for Analysis in the Health Science,* 7th Ed. John Wiley and Sons, New York.

Course Title: Econometrics-II

Course Code	Stat-423	Course Credit	02	Number of Class	20-26	Full Marks	50

Rationale

This course relates more advanced topics in econometrics. Students are expected to have knowledge in Regression Analysis and Econometrics. The emphasis is on understanding the models and the related theories. Through the course, we will apply the theories developed to real-world data and interpret the estimation results in many different respects

Objectives

This course is designed for students to-

- Use various advanced econometric models (Probability model, Dynamic Econometric Model, Structural Equation Model, Non-Linear Model), estimation methods and related econometric theories.
- Apply the above theories to empirical data or be able to develop new econometric theory.

Learning Outcomes

On successful completion of this course, students will be able to-

- Explain the mathematical basis of the linear Probability model, logit, probit and tobit models.
- Use the distributed Lag model , Autoregressive model and Structural Equation Model.
- Explain the role of Non-Linear model and input output analysis.

Course Contents

Probability Model: Detail study of linear probability model, logistic (logit), orderedlogit, generalized ordered logit, probit and tobit models.

Dynamic Econometric Model: Autoregression, distributed lagged variables, lag model, meaning of dynamic distribution lag and autoregressive models role and reasons for lags in econometric model. Method of estimation of lag by Adhocmollud, Koyck and Almon method of estimating distributed lag model, median lag of different models, method of instrumental variable, detecting autocorrelation in autoregressive model by Durbin H-test, Granger causality test.

Non-Linear Model: Non-linear model and principles of non-linear least squares estimation, numerical method of estimating least squares, properties of non-linear regression, Cobb-Douglas and CES production functions, estimation of Cobb-Douglas production function parameters.

Input-output analysis internal efficiency inter-industry relation, application of social accounting matrix in planning and development.

Text Book

1. Gujrati,D. (2003): *Basic Econometrics* 4th edition, McGraw-Hill, New York.
2. Greene, W.H. (2003): *Econometric Analysis,* 5th Ed, Pearson Education

Reference Books

1. Kleim& Miller: An Introduction to Econometrics
2. Johnston, J. (1977): *Econometric Methods,* 4th edition, McGraw-Hill, New York.
3. Desai, M. (1976): *Applied Econometrics,* Oxford Publication.

Course Title: Data Mining

Course Code	Stat-424	Course Credit	03	Number of Class	35-40	Full Marks	100

Rationale

Data mining is an interdisciplinary field which brings together techniques of machine learning, database, information retrieval, mathematics and statistics. These techniques are used to find useful patterns in large datasets. It provides the methods for such knowledge discovery in data bases are required owing to the size and complexity of data collection in administration, business and science.

Objectives

This course will aim to-

- Provide the student with a working knowledge of select topics from data mining and machine learning.
- Particular focus will be on the fundamental statistical properties and analysis of a select few popular techniques for learning, classification and prediction.
- Implement algorithms and running code to solve computationally intensive statistical problems.
- Development of solid theoretical (theorems follows by proofs) analysis of classification error in the simplest machine learning settings.

Learning Outcomes

On successful completion of this course, students will be able to-

- Understand the fundamentals of machine learning and basics of data mining, which is essential for anyone contemplating a career as a professional statistician or data analyst in industries reliant upon such expertise.
- Develop a working knowledge of the statistical and theoretical underpinnings of the topics covered.
- Understand the Statistical association rules.
- Introduce Database/OLTP Systems, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, Data Warehousing and Machine Learning.
- Know the Statistical Perspective on Data Mining, Decision Trees, And Genetic Algorithms.
- Develop appropriate neural network algorithm.
- Implement classification and clustering technique in real world phenomena.

Course Contents

Overview: Concept of data mining and its advantages and disadvantages. Basic Data Mining Tasks: Classification, Regression, Time Series Analysis, Prediction, Clustering, Summarization, Association Rules,andSequence Discovery.Data Mining Versus Knowledge Discovery. Development of Data Mining, Data Mining Issues and Metrics, Social Implications of Data Mining.

Related Concepts: Database/OLTP Systems, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, DimensionalModeling, Data Warehousing, , Machine Learning, Pattern Matching.

Data Mining Techniques: Statistical Perspective on Data Mining, Point Estimation, Models based on Summarization, Bayes Theorem,, Hypothesis Testing, Regression and Correlation, Similarity Measures, Decision Trees, Genetic Algorithms.

Neural Network: Background, Learning, Basic Neuron Model, Perception, Multiplayer Perception, Recurrent Network, Hopfield Network, Boltzanann Machine Network,Kohonen Self Organizing network, Background, Description, Determining the Winning Neuron, Learning Algorithm.

Classification: Issues in Classification, Statistical-Based Algorithms:Regression, Bayesian Classification. Distance-Based Algorithm:Simple Approach, K Nearest Neighbors. Neural Network-Based Algorithms: Propagation, NN Supervised Learning, Radial Basis Function Networks, Perceptions. Rule-Based Algorithms: Generating Rules form a DT, Generating Rules for a Neural Net.

Clustering: Similarity and Distance Measures, Outliers, Hierarchical Algorithms, Partitional Algorithms: Minimum Spanning Tree, Squared Error Clustering Algorithm, K-Means Clustering, Clustering with Genetic Algorithm and Neural Networks. Clustering Large Databases, Clustering with Categorical Attributes, Comparison.

Association Rules: Meaning of Association, Basic Algorithms, AprioriAlgorithm, Sampling Algorithm, Partitioning, Parallel and Distributed Algorithms, Data Parallelism, Task Parallelism, Advanced Association Rule Techniques, Quantitative Association Rules, Correlation Rules, Measuring the Quality of Rules.

Text Book

1. Dunham, M. H. (2003): *Data Mining: Introductory and Advanced Topics,* Pearson Education,
2. Asia.Larose, D. T. (2005):Discovering Knowledge In Data: An Introduction to Data Mining, Wiley Interscience, N.J., USA.

Reference Books

1. Ibrahim, A.M. (2004): *Fuzzy Logic for Embedded Systems Applications,* Elsevier Science, USA.
2. Larose, D.T. (2006): *Data Mining Methods and Models,* Wiley-Interscience, India.
3. Schalkoff, R. (2005): *Pattern Recognition Statistical Structural and Neural Approaches,* John Wiley and Sons, New York.

Course Title: Statistical Data Analysis-IX

Course Code	Stat-425	Course Credit	02	Number of Class	20-26	Full Marks	50

Group A (Design of Experiment-II): 25 Marks

Rationale

This course deals with the concepts and techniques used in the design and analysis of experiments. The concepts and different models of an experimental design will be studied, leading to their statistical analysis based on linear models

Objectives

The main objectives of this course are to-

- Impart students a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications.

Learning Outcomes

- Test the significance of treatment means for various design
- Estimate missing value for RBD and LSD
- Explore the general theory of factorial and block designs and understand this theory sufficiently to find appropriate designs for specific applications

Course Contents

Additivity test of model in case of two way classification, analysis of CRD, RBD, LSD with and without missing observation, problems on factorial experiment, confounding, split plot, balanced incomplete block design, covariance analysis.

Text Book

1. Montgomery D. C. (2005): Design and Analysis of Experiments, 6th edition, Wiley, USA.

Group-B (Biostatistics): 25 Marks

Rationale

This course is designed to teach the basic principles of biostatistics. It can be a first course in biostatistics for those students who will use the knowledge they acquire to enable them to continue learning more advanced techniques in future statistical and bio statistical course work.

Objectives

The objectives of this course are to-

- Learn the probability density function, survival function and hazard function
- Gather knowledge about Non parametric estimation of survival probabilities and their Standard errors from ungrouped and grouped data,
- Construction of survival curves and their confidence belts,
- fit appropriate parametric model to observed data and testing goodness of fit of fitted models.

Learning Outcomes

Upon completion of the course, students are able to-

- Estimate probability density function, survival function and hazard function, Non parametric
- Graphically represents probability density function, survival function and hazard function, Non parametric
- Construct a Kaplan-Meier estimate of the survival function that describes the "survival experience" of a cohort of subjects

- Interpret the result of a log-rank test in the context of comparing the "survival experience" of multiple cohorts
- Understand confounding and interaction in studies
- Use SPSS/STATA package to-
  - o Perform two sample comparisons of means and create confidence intervals for the population mean differences
  - o Compare proportions amongst two independent populations
  - o Interpret output from the statistical software package STATA related to the various estimation and hypothesis testing procedures covered in the course.

Course Contents

Estimation of probability density function, survival function and hazard function, Non parametric Estimation of survival probabilities and their Standard errors from ungrouped and grouped data, Construction of survival curves and their confidence belts, Graduation of life data (Censored and uncensored) by plotting procedures, Fitting of appropriate parametric model (one parameter exponential, two parameter exponential and Weibull) to observed data and testing goodness of fit of fitted models (Kolmogrov Smirnov test, L.R. test), Construction of confidence limits for life parameters for the fitted models, problems related on logistic regression and proportional hazard model.

Text Book

1. Kleinbaum, D.G. (1996): *Survival Analysis, Springer.* New York.
2. Lawless, J.F.(2003) : *Statistical Models and Methods for* Lifetime data, 2nd Ed, Wiley , New York.

Course Title: Statistical Data Analysis-X

Course Code	Stat-426	Course Credit	02	Number of Class	20-26	Full Marks	50

Group A (Econometrics-II): 25 Marks

Rationale

This course relates more advanced topics in econometrics. Students are expected to have knowledge in Regression Analysis and Econometrics with real world data.

Objectives

The course objectives is to apply the advance econometric theory to apply the real world phenomena.

Learning Outcomes

After completion this course students are able to-

- Use the distributed Lag model , Autoregressive model and Structural Equation Model
- Explain the role of Non-Linear model
- Have clear idea about input-Output analysis

Course Contents

Construct Probability Model, Dynamic Econometric Model, Non-linear model and principles of non-linear least squares estimation, numerical method of estimating least squares, properties of non-linear regression, Cobb-Douglas and CES production functions, estimation of Cobb-Douglas production function parameters.

Text Book

1. Gujrati, D. (2003): *Basic Econometrics* 4th edition, McGraw-Hill, New York.
2. Greene, W.H. (2003): *Econometric Analysis,* 5th Ed, Pearson Education

Group-B(Data Mining): 25 Marks

Rationale

The course is designed to finding hidden information from real world phenomena.

Objectives

The main objective of the course is to-

- Determine the minimum distance decision boundary.
- Perform different classification techniques.
- Determine the partition set of data.

Learning Outcomes

After completion of the course, students are able to-

- Understand different Bayesian approach.
- Know the K-Means algorithm.
- Know the Statistical Perspective on Data Mining, Decision Trees, And Genetic Algorithms.
- Develop appropriate neural network algorithm.
- Implement classification and clustering technique in real world phenomena.

Course Contents

Determination of Partition of Set of Data by Sum of Squares of Errors, Clustering Criteria, Hierarchical Clustering by Nearest Neighbor, Further Neighbor, K-Means Method or Algorithm, Determination of Minimum Distance Decision Boundary, Performing K-NN Classification Using Euclidean and Statistical Matrix, Application of Different Rules of Data Mining, Classification by Regression Tree, Decision Tree, Bayesian Approach, Neural Network.

Text Book

1. Dunham, M. H. (2003): *Data Mining: Introductory and Advanced Topics,* Pearson Education,

Course Title: Project Report

Course Code	Stat-427	Course Credit	03	Number of Class		Full Marks	100

Rationale

Statistics project report are communicating research findings and to support hypotheses and give credibility to research methodology and conclusions. It is important for researchers and also consumers of research to understand statistics so that they can be informed, evaluate the credibility and usefulness of information, and make appropriate decisions.

Objectives

The objectives of the project report is to-

- Describe the data source
- Have Accuracy in data analysis
- Have Accuracy of conclusions and discussion
- Overall clarity and presentation
- Have significance of the study

Learning Outcomes

At the end of the project report student will able to-

- Write the proposal of a report
- Find out a research gap
- Collect usual data of related field
- Formulate the data for analysis
- Analyze the data
- Make result discussion
- Make conclusions
- Suggest the recommendations

Course Contents

There are no specific contents for project report. In the project report students will communicate with the supervisor of related fields. They will complete total project work within a time frame which declared by the exam committee.

Course Title: Viva-Voce

Marks	50	Credits	02