KANNUR UNIVERSITY

(Abstract)

M.Sc. Statistics Programme under – Choice Based Credit Semester System-Revised Scheme and Syllabus -Implemented with effect from 2013 admission -Orders issued.

ACADEMIC BRANCH

U.O. No. Acad/C4/9728/2013 Dated, Civil Station (P.O), 06-05-2015

Read: 1.U.O No.Acad/C3/2049/2009, dated 11.10.2010

2.U.O.No.Acad/C3/2049/2009 dated 05.04.2011

3. Minutes of the meeting of the Department Council held on 26/07/2013

4. Minutes of the meeting of the Curriculum Committee held on 10/04/2015

5. Letter No. Nil dated 10/04/2015 from HOD, Dept. of Statistical Sciences, Mangattuparamba Campus.

ORDER

1. The Regulations for Post Graduate Programmes Under Choice Based Credit Semester System were implemented in the Schools/ Departments of the University with effect from 2010 admission as per paper read (1) above and certain modifications were effected to the same vide paper read (2).

2. The Department Council as per paper read (3) above approved the revised Scheme and Syllabus of M.Sc. Statistics Programme under choice based credit semester system for implementation with effect from 2013 admission.

3. The Curriculum Committee as per paper read (4) above approved the revised Scheme and Syllabus of M.Sc Statistics Programme under Choice Based Credit Semester System for Implementation w.e.f.2013 admission.

4. The head of the Department, Department of Statistical Sciences, vide paper (5) has forwarded the revised Scheme and Syllabus for PG Programme in M.Sc Statistics in line with the Choice Based Credit Semester System for implementation with effect from 2013 admission.

5. The Vice-Chancellor, after considering the matter in detail, and in exercise of the powers of the Academic Council, conferred under Section 11 (1) of Kannur University Act, 1996 and all other enabling provisions read together with, has accorded sanction to implement the revised Scheme, and Syllabus for PG programme in M.Sc. Statistics under Choice Based Credit Semester System with effect from 2013 admission subject to report to the Academic Council.

5. Orders are, therefore, issued accordingly.

6. The Revised Scheme and Syllabus is appended.

P.T.O

Sd/-
DEPUTY REGISTRAR (ACADEMIC)
For REGISTAR

To:

The HoD, Dept. of Statistical Sciences
Mangattuparamba Campus.

KANNUR UNIVERSITY
CIVIL STATION P.O.
KANNUR
Pin-670 002
HAVAKKARA

Forwarded by Order

SECTION OFFICER

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1. The Examination Branch (through PA to CE)
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4. SF/DF/FC

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KANNUR UNIVERSITY
DEPARTMENT OF STATISTICAL SCIENCES

PROGRAMS OFFERED IN THE DEPARTMENT

I. **Post Graduate Program: MSc. Statistics, Choice Based Credit & Semester System (CCSS).**
II. **Research Program: PhD in Statistics.**
III. **Inter Disciplinary Program: Open Courses.**

THE COURSE STRUCTURE & SYLLABUS

A. The Course Structure

I. Post Graduate Program: MSc. Statistics, Choice Based Credit & Semester System (CCSS).

1.1 Eligibility for Admission:

Candidates who have studied either Statistics as main or Mathematics main with Statistics subsidiary at the UG level alone are eligible for admission.

The minimum requirement for admission to a Post Graduate Program shall be Grade C or overall CGPA 1.5 under CCSS /Grade C+ or CGPA 2 in Part III under grading system subject to satisfying other eligibility criteria prescribed for P.G program of the Kannur University.

1.2 Number of Seats: 25.

1.3 Mode of selection: The selection will be based on the marks obtained for the qualifying examination and an Entrance test to be conducted by the department. (As per the new regulation Entrance test will be conducted only if the number of applications received exceeds 3 times the sanctioned strength of the program). The Entrance test shall be of the objective type of duration 2 hours, based on BSc. level Mathematics, Statistics and complimentary level Computer science syllabus .

1.4 Relaxation & Weightage:

Usual relaxation of marks or GPA shall be given to eligible categories as per the following rules

a) SC/ST Category: minimum pass marks in the relevant subjects or part of subjects is required for admission to PG Degree program.
b) OBC Category: a relaxation of 5% of marks in the concerned subjects or part of subjects from the prescribed minimum is allowed.
c) OEC Category: a relaxation of 5% of marks in the qualifying examination from the prescribed minimum is allowed.

1.5 Reservation Norms:

SI.No	Seat Reservation		% of Reservation
I	Open Quota (on the basis of merit)		50
II	a) Ezhava /Thiyya	8%	20
	b) Muslim(MU)	7%	
	c) LC other than Anglo Indian	1%	
	d) Other backward Christian(BX)	1%	
	e) Other backward Hindu (BH)	3%	
III	BPL among forward communities		7.5
IV	Scheduled Castes/ Scheduled Tribes		22.5
	Scheduled Castes	15%	
	Scheduled Tribes	7.5%	

1.6 Grace marks and Ranking:

Criteria for computation of Index score and ranking on the basis of CGPA obtained by the candidate for admission to Post Graduate Programs for the Academic Year 2012 onwards.(**Refer APPENDIX to U O No.Acad/D2/1121/2003(Vol.II)dt. 16-07-2012).**

Computation of Index Score.

The following steps shall be adopted for the computation of Index scores while ranking the students for admission to various P G programs. The required Index score shall be obtained in four steps. These four steps shall consist of computing an Initial Index Score, Second Index Score, Third Index Score and Final Index Score.

Computation of the Initial Index Score

The Initial Index shall be computed as follows.

a) Based on CCSS(2009 admission onwards)

The Initial Index Score of those students who have done their qualifying degree under CCSS is the Credit Grade Point Average scored by him/her in Core and Complementary courses. The Credit Grade Points(C.G.P) of the courses concerned shall be obtained by multiplying the C.G.P.A with the corresponding credits; obtaining the total of such values and then dividing it by the total of the credit values associated with the courses.

Formula for calculating Initial Index Score for MSc.Statistics Programme.

i) BSc Statistics Students:

Initial Index Score = (Total C.G.P+C.G.P of core)/(78+54), If entrance test is not held.

Initial Index Score= [(Total C.G.P+C.G.P of core)/(78+54)+E/25]/2

ii) BSc Mathematics Students:

Initial Index Score= (Total C.G.P+C.G.P of Complementary I)/(78+12), If entrance test is not held.

Initial Index Score=[(Total C.G.P+C.G.P of Complementary I)/(78+12)+E/25]/2

Where C.G.P=Credit x CGPA, E= Entrance test score.

Computation of Second index Scores:

The Second Index Scores shall be computed by adding the 'grace scores'(G) to the Initial Index Scores. The students who have done their qualifying degree from Kannur University are eligible for a grace score, which is equal to 5% of the Initial Index Score obtained in the pervious step.

If the candidate has done the qualifying degree from Kannur University, the Second Index score of this candidate is: Initial index + (Initial Index*5%).

In the case of other students, the grace score is zero. ie, the Second Index Score is same as the Initial Index Score.

Computation of Third Index Score:

The Third Index Score shall be adding the 'bonus score'(B) to the Initial Index Score. NCC and NSS candidate are eligible for bonus score. The bonus score for NSS and NCC candidate is 0.04. NCC "B" certificate and 'C' certificate holders are eligible for an additional scores of 0.02 and 0.04 respectively.These scores are to be added to the Second

Index Scores in the case of NCC and NSS candidates. In the case of other students, the bonus score is zero. ie, the Third index Score is same as the Second Index Score.

Computation of the Final Index Score:

The final Index Score shall be obtained by subtracting a 'handicap score'(H) of 0.04,0.08 and 0.01 from the Third Index Score of those students who have taken two chances, three chances and more than three chances respectively for completing their qualifying examination. The number of chances means the number of chances taken for passing any part of the qualifying examination. Betterment of examination will not be considered as the chance. In the case of students who have taken only one chance for passing the qualifying examination, the 'penalty score' is zero, ie, the Final Index score is same as the Third Index Score.

Breaking of a Tie in Final index :

(i) If two or more candidates have same Final Index, priority must be given to the candidate who scored more marks(in mark system)/more Weighted Grade Points(WGP, in Grading System)/Credit Grade Point Average in the qualifying for the subject for which admission is sought.

(ii) If two or more candidates have the same Final index even after this, priority must be given to candidate who scored more marks(in mark system)/ more Weighted Grade Points(WGP, in Grading System)/Credit Grade Point Average in the compulsory or first subsidiary or Complementary subject.

(iii) If the Final index is still the same, priority should be given to the candidate who scored more marks(in mark system)/ more Weighted Grade Points(WGP in grading system)/ Credit Grade Point Average in the compulsory or second subsidiary(optional) or Complementary subject.

(iv) If the Final index is still the same, priority should be given to the candidate who scored more marks(in mark system)/ more Weighted Grade Points(WGP in grading system)/ Credit Grade Point Average in the first language English/ common course1.

(v) If the Final index is still the same, priority should be given to the candidate who scored more marks(in mark system)/more Weighted Grade Points(WGP in grading system)/ Credit Grade Point Average in the second language / common course 2.

More details regarding ranking and reservation can be had from the Revised criteria for conversion of Grade and CGPA/SGPA in to percentage of marks and computation of Index score and ranking for admission to PG programs in the University order **Appendix to UONo.Acad/D2/1121/2003 (Vol.II)dt.16-07-2012)**

1.7 Duration of the MSc. Program: Two Years. The program is divided into 4 semesters of not less than 90 working days each.

1.8 Applications for Admission and Course fee: The Application fee, Course fee and Examination fee shall be as per the general rules and guidelines of the University which shall be specified in the Prospectus to be published every year prior to the admissions for that academic year.

1.9 The Courses and Credits: The MSc. program consists of three types of courses - Core, Elective and Open courses.

M.Sc. Program in Statistics shall consist of Sixteen Core courses, at most five Elective courses that can be selected from the long list of elective courses which are grouped into five specialization branches and at most two Open courses. The total credits for the core courses shall be 60 while each elective/open course shall be of 4 credits. The minimum total credits

required for the successful completion of the MSc. Program is 80 of which 60 must be from core courses and at least 12 from electives. Those who do not secure the minimum total credits from core and elective courses together have to supplement the deficiency from the open courses.

Courses of M.Sc. Program

Course Code	Name of course	Credits
Semester I		
DSS-C101	Mathematical Methods I	4
DSS-C102	Mathematical Methods II	3
DSS-C103	Probability Theory I	3
DSS-C104	Distribution Theory & Estimation	3
DSS-C105	Sampling Methods	3
DSS-E101	Elective I	4
O101	Open I (conducted by other Depts.)	4
Semester II		
DSS-C206	Probability theory II	4
DSS-C207	Regression Analysis	3
DSS-C208	Testing of Hypotheses	3
DSS-C209	Multivariate Analysis	3
DSS-C210	Design of Experiments	3
DSS- E202	Elective II	4
Semester III		
DSS-C311	Stochastic Processes	4
DSS-C312	Operations Research	3
DSS-C313	Time Series & Queuing Theory	3
DSS- E303	Elective III	4
DSS- E304	Elective IV	4
DSS- E305	Elective V	4
Semester IV		
DSS-C414	Statistical Computing with R - Lab I	4
DSS-C415	DATA Analysis Using SPSS - Lab II	4
DSS-C416	Project/Dissertation	10

Total courses 22 (Core 16 + Elective 5 +Open 1)

Total credits required 80 (Core 60 + Electives& Open 20)

List of Elective Courses

Course Code	Name of course	Credits
EL01	Actuarial Methods & Insurance	4
EL02	Actuarial Models	4
EL03	Advanced Multivariate Analysis	4
EL04	Advanced Probability	4
EL05	Advanced Sampling Theory	4
EL06	Advanced Stochastic Processes	4
EL07	Analysis of Clinical Trials	4
EL08	Analysis of Discrete and Longitudinal Data	4
EL09	Bayesian Econometrics & Game Theory	4

EL10	Data Structures & Programming in R	4
EL11	Demography	4
EL12	Econometrics Methods	4
EL13	Economic Development & Growth Models	4
EL14	Industrial Quality Control	4
EL15	Knowledge Discovery & Data Mining	4
EL16	Life Contingencies	4
EL17	Queues and Inventories	4
EL18	Statistical Ecology & Genetics	4
EL19	Statistical Methods in Medical Research	4
EL20	Statistical Pattern Recognition	4
EL21	Statistical Software- R and SPSS	4
EL22	Stochastic Epidemiology	4
EL23	Stochastic Models in Finance	4
EL24	Survival Analysis and Bayesian Inference	4

To gain the capacity to work with full confidence in any of the most important fields of Statistics, one requires detailed study of several related elective courses. Such related elective courses are grouped into **five** important branches known as **Specialization Branches** as given below.

Branch 1. Actuarial Statistics.
Branch 2. Biostatistics.
Branch 3. Computational Statistics.
Branch 4. Econometrics.
Branch 5. Mathematical Statistics.

The list of Elective courses in the **Specialization Branches** are given below.

Branch 1: Actuarial Statistics.

EL01 Actuarial Methods & Insurance
EL02 Actuarial Models
EL08 Analysis of Discrete and Longitudinal Data
EL16 Life Contingencies
EL21 Statistical Software- R and SPSS
EL23 Stochastic Models in Finance
EL24 Survival Analysis and Bayesian Inference

Branch 2 : Biostatistics

EL07 Analysis of Clinical Trials
EL08 Analysis of Discrete and Longitudinal Data
EL11 Demography
EL18 Statistical Ecology & Genetics
EL19 Statistical Methods in Medical Research
EL21 Statistical Software- R and SPSS
EL22 Stochastic Epidemiology
EL24 Survival Analysis and Bayesian Inference

Branch 3. Computational Statistics

EL03 Advanced Multivariate Analysis
EL05 Advanced Sampling Theory
EL08 Analysis of Discrete and Longitudinal Data
EL10 Data Structures & Programming in R
EL15 Knowledge Discovery & Data Mining

EL20 Statistical Pattern Recognition
EL21 Statistical Software- R and SPSS
EL24 Survival Analysis and Bayesian Inference

Branch 4: Econometrics

EL09 Bayesian Econometrics & Game Theory
EL12 Econometrics Methods
EL13 Economic Development & Growth Models
EL14 Industrial Quality Control
EL17 Queues & Inventories
EL21 Statistical Software- R and SPSS
EL23 Stochastic Models in Finance

Branch 5: **Mathematical Statistics**

EL03 Advanced Multivariate Analysis
EL04 Advanced Probability
EL06 Advanced Sampling Theory
EL07 Advanced Stochastic Processes
EL12 Econometrics Methods
EL21 Statistical Software- R and SPSS

Student can select **FOUR or FIVE** elective courses either belonging to the same specialization branch or others. Each student has to do a Project work either Theoretical or Data Analysis type under the guidance of a faculty member during the fourth semester. **Those who complete at least four electives from the same specialization branch and do a project work in the same area shall be eligible for MSc. DEGREE IN STATISTICS WITH SPECIALIZATION in that branch.**

Open courses: These are courses offered by other departments of the university. Students can join for the Open courses instead of Elective courses depending on their choice and availability of seats in the departments offering such courses.

The allotment of specialization branch based on the candidates preferences and the selection of topic of project work shall be made at the beginning of the SECOND semester. The department may fix a maximum/minimum student strength for offering a specialization branch depending on the availability of faculty and other facilities. If several students demand for the same specialization branch, and the department decides to offer more than one specialization branch, the selection of students for the branch shall be made on the basis of the over all performance of the students up to the Second semester. The department will have the full right to cancel, modify or add the Elective courses any time prior to making final allotments to the students in a batch. The following two Core courses, STATISTICAL COMPUTING with R- Lab I and DATA ANALYSIS using SPSS –Lab II offered in the fourth semester, are fully computer based lab works intended to master the use of all important Statistical Packages in R & SPSS Procedures related to the topics of study in the I, II and III semesters of the course. Examinations on these two papers will be computer based using the software prescribed to do the Lab assignments and will be conducted by the department.

The content of each course (Core and Electives) is divided into 4 units of equal weights. Each unit shall have about 23 hrs instruction of which $1\frac{1}{2}$hrs for test, 4 hrs. for problem solving and 5 hrs for discussions and seminar.

1.10 **Evaluation:** There shall be two modes of evaluation – the Continuous Assessment (CA) and the End Semester Assessment (ESA).
The total mark for each course including the Project shall be divided into 40% for CA and 60% for ESA.

1.10.1 Continuous Assessment: The component wise division of the 40% CA mark are as follows

Component	Core		Elective /Open	Project
	Theory	LAB (I,II)		Component
Seminar/Presentation/ Oral test.	12%	20%	12%	Synopsis - 15% Material
Assignments/Problem solving.	16%	16%	16%	Collection - 15% Timely
Tests.	12%	4%	12%	completion - 10%
Total	40%	40%	40%	40%

The following criteria shall be followed in the assignment of CA.

Theory Assignments/ Problem solving: Problem solving is compulsory for all Theory courses. In addition to the textbook problems, students are to collect as many problems as possible from the question papers of past national level competitive tests and solve them in the class along with the course work. Course wise records of problem solutions to be kept as proof of the work done. Unit wise problem solutions/assignments are to be submitted within the specified time. Weightage for CA score will be - timely submission 20%, sincere self attempt 40% & correct solution 40%.

Lab Assignments: Separate reports of the Lab assignments for the two courses containing a brief descriptions of the methodology , formula and computational techniques, program, data used, the outputs obtained and a clear interpretation of the results to be submitted. The time frame for submitting the report shall be the same as in the case of theory assignments. Each candidate has to make presentations of the Lab work for the assessment.

Seminar/Presentations: Every student shall make at least one seminar presentation for about 30 minutes duration on each theory course of study. The typed script of the seminar shall be supplied to the class at least one day prior to the presentation. The weights for CA for Seminar shall be - timely submission of script 20%, 20% for content, 40% for presentation and 20% for discussion after presentation.

Test: There shall be at least 3 internal tests for each course either unit wise or combining units. The average of the best two will be considered for CA mark.
Those who fail to take the seminars or test on the scheduled date for genuine reasons; the department council may give another chance.

1.10.2 End Semester Assessment (ESA): The ESA shall be made based on examinations for each course conducted by the Department/University as per the common norms under the CCSS. The question paper for ESA for Theory examinations shall contain three sections.
Section 1-SIX very short answer questions, not omitting any Unit, to answer **any Four**.
Section 2- SIX short answer questions, not omitting any Unit, to answer **any Four**.
Section 3-SIXdescriptive answer questions, not omitting any Unit, to answer **any Four**
The Question paper should not contain more than 5 questions from the same unit.

LAB examination in the IV Semester: Statistical Computing with R Lab I and DATA ANALYSIS using SPSS Lab II shall be made on the basis of computer based Lab examinations of duration 3 hours each. There shall be a board of at least three examiners for the conduct of the practical examinations – one external, one or two internal and the chairman. The board will set the question papers and conduct the examinations. The valuation of the practical exam scripts shall be made on the day of the examination itself by the board of examiners.

Project work: In the revised syllabus the project work is given more weightage with 10 credits. The duration of the project work is 4 months. Candidates can either do the project work in the department itself or can go to any reputed department/ institution outside the campus, approved for doing research or advanced studies. The department/University may establish close link with such institutions for the purpose , by way of executing appropriate MOU if required.

Project evaluation: Each candidate has to submit 2 print copies & a soft copy of the Project report approved by the project guide before the last date fixed by the department. The candidate has to present the project before the board of examiners consisting of the duly appointed external examiners which will be followed by a Viva. The ESA for the project will be made jointly by the board of examiners based on the report, its presentation and Viva. The division of the project ESA [60%] are – 20% for innovative study , 10% for coverage and clarity , 10% for publication and 20% for presentation & viva.

All other common university norms for conducting ESA for Choice based Credit & Semester System (CCSS) shall be followed. The norms for Grading and Pass/Fail and re-appearance etc will be the same as for other MSc. Programs following CCSS.

II . Research Program: PhD. in Statistics.

The department is an approved research centre in Statistics. Scholars with outstanding academic achievements and research aptitude can join for part time/fulltime research leading to PhD degree in Statistics under the Faculty of Science.

2.1 Eligibility for Admission: The PhD admission is made as per a common schedule of the university, usually notified twice in a year, in the months of January and June. The selection of scholars for PhD registration will be based on the common guide lines prescribed by the university. Full time research scholars not in receipt of any other fellowships may get university scholarship depending on their eligibility and availability of funds.
2.2 Area of Research: The area of research depends on the availability of experts in the department. At present scholars in the areas of Stochastic modeling and Biostatistics are working in the department.

III . Open Courses under PG Choice Based Credit & Semester System.

The following inter disciplinary courses are offered in the department as open courses. Post graduate and research students of other disciplines are eligible to join the course. Each course is of duration 70 hrs.

DSS-O01 Statistical Methods (Total credits 4-Theory 3+Practical 1).
This course is for those who have not studied Statistics at the main or subsidiary level for their qualifying examination.

DSS-O02 Data Analysis and Statistical Decision Making (Total credits 4 - Theory 3+Practical 1).
This course is for Post graduate students and Researchers who have studied mathematics/statistics at subsidiary level for their qualifying examination.

DSS-O03 Operations Research (Total credits 4- Theory 3+Practical 1).
This course is for Post graduates students of Computer Science, Computer Applications, Commerce, Economics, Management Studies and Mathematics and Physics.
The open courses shall be conducted only if the department has facility and sufficient faculty strength.

B. The Detailed Syllabus

Core Courses

Semester I

DSS-C101 Mathematical Methods I (Total Credits 4)

Unit 1: Class of sets, Fields and σ-Fields, minimal σ-fields and Borel fields in one and higher dimensions. Limits of sequence of sets, monotone class. Set function, sub additive and additive set functions. Lebesgue exterior measure and its properties.
Unit 2: Lebesgue measure, measurable sets, measure space and measurable space, different types of measures, extension theorems(without proof). Measurable function, elementary, simple, nonnegative and general measurable functions. Sequence of measurable functions and their limits and convergence, Egoroff's theorem.
Unit 3: The Riemann-Stieltjes integral, necessary and sufficient condition for integrability, fundamental theorem of integral calculus, Improper integrals, the beta and gamma functions. Laplace transform. Product space and product measure. Fubini's theorem (without proof). Evaluation of multiple integrals by repeated integration.
Unit 4: Lebesgue integration and its properties. Monotone convergence theorem, Fatou's lemma and dominated convergence theorem. Absolute continuity of a measure wrt another measure, Radon-Nikodym theorem (without proof) and its applications. Lebesgue decomposition theorem(without proof).

Books for study

1. Basu, A K(2009): Measure Theory and Probability, PHI
2. Bhat, B R (2007): Modern Probability Theory, New Age Publishers
3. Jain, P K and Gupta(2007): Lebesgue Measure and Integration, New Age
4. Malik, S. C. (2008): Mathematical Analysis, New Age Publishers

Books for Reference

1. Ash, R.B (1972) Real Analysis and Probability, A P
2. Bartle, R.G. (1996): The Elements of integration. JW,NY
3. Billingsley, P. (1986): Probability and Measure (John Wiley & Sons)
4. Royden, H L (1995): Real Analysis, PHI

DSS-C102 Mathematical Methods II (Total credits 3)

Unit 1: Continuous functions, uniform continuity and absolute continuity.Real Sequences and series,Sequences and series of functions. Point wise and uniform convergence, tests for uniform convergence, the Weirstrass theorem.
Unit 2: Functions of several variables, limits and continuity. Partial and total derivatives, directional derivatives and continuity. Taylor's theorem and its application. Conditions for the optima of multivariate functions.
Unit 3: Linear vector space and subspaces, dependence and independence, Basis and dimensions, Orthogonal basis, Linear transformation, Matrices and their properties, Rank and inverse, characteristic roots and vectors and their properties, spectral decomposition**.** Generalized inverse and its properties.
Unit 4: Quadratic forms, their classification, properties and reductions. Solution of system of linear equations. Solutions of Non linear equations-Bisection, Newton Raphson methods.
Books for Study:

1. Biswas, S(2006): Introduction to the Theory of Matrices.
2. Gilbert Strang (2008): Linear Algebra and its Applications 4th edition, Cengage Learning.
3. Malik, S C (2008) :Mathematical Analysis, New Age Publishers.
4. Searle, S. R. (1982): Matrix Algebra Useful for Statistics, John Wiley & Sons

Books for References:

1. Apostol, T. M. (1975): Mathematical Analysis: A Modern Approach to Advanced Calculus. Addison – Wesley
2. David V Widder: Advanced Calculus, Prentice Hall of India
3. Hughes Hallett (2008) Calculus, Single and Multivariable, IDGBKS
4. Mathai, A M (1998): Linear Algebra Part I, II & III., Centre for Mathematical Sciences.
5. Pringle & M Rayner: Generalised Inverse of Matrices with Application to Statistics, Griffin, London.
6. Rao, C R (2002): Linear Statistical Inference and its Applications,Wiely.
7. Seymour Lipschupz, Marc Lipson(2005) Schaum's outline Series: Linearalgebra 3rd edition. Tata McG Graw Hill

DSS-C103 Probability Theory I (Total credits 3)

Unit 1: Probability measure and its properties. Discrete and general probability spaces. Random variables, sequence of random variables and limits, extension of probability measure, Caratheodory extension theorem (without proof). Induced probability measure, Conditional probability measure and independence of events, Distribution function and its inverse, properties and decomposition. Distribution function of vector valued random variable and independence.
Unit 2: Lebesgue-Stieltjes measure and integral. Expectation of real and complex valued random variables and its properties convergence theorems on expectation. Generating function and its properties. The probability and moment generating functions, characteristics function and their properties.
Unit 3: Inequalities involving moments- Cr inequality, Jenson's inequality, basic inequality, Markov inequality and Kolmogorov inequality, applications. Inversion and Uniqueness theorems.
Unit 4: Order statistics, their distributions and properties, distribution of sample median, range and extreme value distributions.
Books for study

1. Basu, A K(2009): Measure Theory and Probability,PHI
2. Bhat, B R(2007) : Modern Probability Theory, New Age Publishers

3. Bhuyan A C (2010): Probability Distribution theory and Statistical Inference, New Central Book Agency P Ltd London.
4. Goon, Gupta, Das Gupta(2001): An Outline Series in Statistics Vol I. World Press

Books for Reference

1. Arnold (2008): A first course in Order Statistics, Siam.
2. Ash, R.B (1984): Probability and Measure Theory,New Age.
3. Balakrishnan and Rao (1998): Hand Book of Statistics Vol – 17, Elsevier.
4. Billingsely, P (1989): Probability and Measure.
5. Rao, C R (2002): Linear Statistical Inference and its Applications, New Age

DSS-C104 Distributions Theory & Estimation (Total credits 3)

Unit 1: Revision of standard discrete and continuous distributions. The power series distributions and its characteristics, particular cases. Pareto, Lognormal, Logistic, Weibull, Laplace and Cauchy distributions and their properties.

Unit 2: Sampling distributions: Joint distribution of mean and variance from normal population, Chi-square, t and F distributions (central and non central) and their properties and applications. Standared error of moments and their functions, large sample case only.

UNIT 3: The problem of point estimation. Sufficiency and the Factorization theorem. Minimal sufficiency and completeness. Cramer-Rao inequality. Battacharya bound. Fishers information measure. Minimum variance unbiased estimator, Rao-Blackwell and Lehman-Scheffe Theorems.

Unit 4: Methods of estimation- Maximum likelihood, properties of MLE. Minimum chi-square, modified minimum chi-square, method of moments and quantiles, method of least squares and method of minimum variance. Comparison of the methods and their characteristics. Interval estimation- shortest confidence and unbiased confidence intervals, central and noncentral confidence interval Fiducial interval.

Books or study:

1. Bhuyan A C (2010): Probability Distribution theory and Statistical Inference, New Central Book Agency P Ltd London.
2. Goon, Gupta, Das Gupta (2001): An Outline Series in Statistics Vol II, World press.
3. Parimal Mukhopadhyay (2006): Mathematical Statistics, Arunaba Sen.
4. Rohatgi, V. K.(1976): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Books for Reference

1. Dudewicz, E. J. and Mishra, S.N.(1988) Modern Mathematical Statistics, JW
2. Johnson,Kotz,and Balakrishnan(2004): Continuous Univariate Distributions, Vol.1&2, JW.
3. Kale, B.K. (1999): A First Course on Parametric Inference (Narosa)
4. Kendall & Stewart(1981): The advanced theory of Statistics, Vol.1 & 2.
5. Lehmann, E. L. (1988): Theory of Point Estimation ,John Wiley
6. Mood, A.M, Grabll, F.A(2001): Introduction to the Theory of Statistics**.**
7. Rao C R(2002): Linear Statistics Inference and its Applications,Wiely.

DSS-C105 Sampling Methods (Total credits 3)

Unit 1: Review of the simple sampling methods- Stratified sampling with varying probabilities, estimation of population mean, proportion & variance, problem of allocations, comparison of efficiency, post stratification.

Unit 2: Multistage sampling – Two stage cluster sampling with equal second stage clusters. Double sampling and its applications. Multi phase and sequential sampling.

Unit 3: Sampling with varying probabilities – PPS sampling with & without replacement, Mudzuno scheme of sampling, ordered & unordered estmators- Desraj's ordered estimator, Horvitze-Thompson & Yates Grundy estimators, Murthy's unordered estimator, systematic PPS sampling.

Unit 4: Ratio and Regression estimators, bias and approximate variances. unbiased ratio estimator. Difference estimator, comparison of regression estimator with ratio estimator.

Books for study:

1. Cochran.W.G (2007): Sampling Techniques, Wiely.
2. Gupta & Kapoor (2010) Fundamentals of Applied Statistics. Sultha Chand & Co
3. Parimal Mukopadhyay(2012): Theory & Methods of Survey Sampling, PHI
4. Sampath S (2005): Sampling Theory and Methods, Narosa.

Books for reference:

1. Des, Raj,D.: Sampling Theory, McGraw Hill
2. Des, Raj D and Chandhok, P. (1998): Sample Survey Theory, Narosa.
3. Hansen M.H, Hurwitz,W.N. & Madow,W.G: Sample Survey Methods & Theory.
4. Murthy, M.N: Sampling Theory & Methods. Statistical Publishing Society.
5. Sing, D and Chaudhury F S. (1986): Theory and Methods of Survey Sampling, PHI
6. Sukhatme, P.V., Suktatme, B.V., Sukhatme, S. and Asok, C. (1984): Sampling Theory of Surveys With Applications, Indian Soc. For Agricultural Statistics, New Delhi.

Semester II

DSS-C206 Probability theory II (Total credits 4)

Unit 1: Different modes of convergence, almost everywhere, in probability, in distribution, in r^{th} mean and almost sure, their mutual implications. Characteristic function and weak convergence of distributions. Helly's convergence theorem, Helly-Bray lemma, Scheffe theorem. Continuity theorem on characteristics function, applications.

Unit 2: Independence of class of events and random variables. Borel 0-1 criteria and Borel Cantelli Lemma, Kolmogorov 0-1 laws. The Weak laws of large numbers, the strong laws of large numbers and Kolmogorov three series theorem, applications. The law of iterated logarithm.

Unit 3: The central limit theorems- Lindberg-Levy, Liapounov and Lindberg-Feller (without proof) central limit theorems, their mutual implications and applications. The multivariate central limit theorem. The Bochner theorem and the moment sequence theorem on distribution (without proof).

Unit 4: Infinitely divisible distribution statistics and their properties. Compound and mixture distributions, families of distribution, orthogonal polynomials.

Books for study

1. Bhat, B R (2007): Modern Probability Theory, New Age Publishers
2. Johnson, Kotz and Balakrishnan(1994): Continuous Univariate Distributions,Vol.1, JW
3. Rao, C R (2002): Linear Statistical Inference and its Applications.
4. Rohatgi, V. K.(1976): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Books for Reference

1. Ash, R.B (1972) Real Analysis and Probability, A P
2. Basu, A K(2009): Measure Theory and Probability,PHI
3. Billingsely, P: Probability and Measure.
4. Goon, Gupta, Das Gupta (2001): An Outline Series in Statistics Vol 1.
5. Kendall & Stewart: The advanced theory of Statistics, Vol.1 & 2.

DSS-C207 Regression Analysis (Total credits 3)

UNIT 1: Linear estimation- Estimability of linear parametric functions, estimation space and error space, linear estimation and Gauss-Markov theorem, tests of linear hypothesis Variance-Covariance of LS estimators.

UNIT 2: Linear Regression models, the simple linear regression models, least square estimation, statistical assumptions and properties of estimators, Autocorrelation and its test, standard error of estimates, tests of significance and confidence intervals for the parameters, error and residual plots.

Unit 3: Weighted least squares. Multiple regression models, OLS and ML estimators, Distributions, MANOVA, Testing and Prediction.

Unit 4: Non Linear regression: Polynomial regression in one and several variables. Linearization transforms, Diagnostic checks and correction. Generalized linear models. Logistic regression.

Books for study

1. Draper,N. R. & Smith,H (1998): Applied Regression Analysis, 3rd Ed .John Wiley.
2. Goon, Gupta, Das Gupta (2001): An Outline Series in Statistics Vol 1I, World Press.
3. Hosmer, D.W. & Lemeshow, S. (1989): Applied Logistic Regression, John Wiley.
4. Rao, C R (2002): Linear Statistical Inference and its Applications, Wiley.

Books for Reference

1. McCullagh,P & Nelder, J. A (1989): Generalized Linear Models, Chapman & Hall.
2. Montgomery DC , Peek E A, Vining G G(2006): Introduction to Linear Regression Analysis ,JW.
3. Neter, J., Wasserman, W., Kutner, M.H. (1985): Applied Linear Statistical Models. Charles Griffin & Co
4. Ratkowsky, D.A. (1983): Nonlinear Regression Modelling, Marcel Dekker.
5. Seber, G.A.F. and Lee, AJ. (2003): Linear Regression Analysis, Wiley
6. Sengupta D and Jammalmadka SR (2005): Linear Models: An integrated Approach, World Scientific.

DSS-C208 Testing of Hypotheses (Total credits 3)

Unit 1: Problem of testing of hypotheses- The classical Neymann-Pearson approaches and its generalization. MP tests, UMP tests.

Unit 2: Completeness and bounded completeness. Unbiased critical regions of type A and B, Similar regions, Neyman's structure and its applications, LMPU tests.

Unit 3: Likelihood ratio tests and their properties. Asymptotic distribution of likelihood ratio tests. SPRT and its applications.

Unit 4: Non parametric tests- Chi-square test, Kolmogrov-Smirnov test, Sign test, Signed rank test, Wald-Wolfowitz run test, Median test, U-test, one & two sample cases. Robustness, Nonparametric confidence interval. Levene's test. Nonparametric ANOVA-the Kruskal Walli and Freid Mann test.

Books for study

1. Casella, G. and Berger, R L (2002): Statistical Inference, Duxbury, Australia.
2. Conorer W J(2006): Practical Non parametric Statistics, JW
3. Rohatgi, V.K(2006): An Introduction to Probability Theory and Mathematical Statistics, Wiley.
4. Wald A (1952): Sequential Probability Ratio Tests.

Books for Reference

1. Gibbons S (2003): Nonparametric Statistical Inference,CRC.
2. Lehman: Testing Statistical Hypotheses.
3. Rao C R: Linear Statistics Inference.
4. Siegal : Nonparametric methods.
5. Zacks : Statistical Inference.

DSS-C209 Multivariate Analysis (Total credits 3)

Unit 1: Multivariate distributions, marginal and conditional distributions basic notions and examples. Multivariate normal distribution and its characteristics, characterization. Samples from multivariate normal distribution, Estimation of the mean vector and dispersion matrix.

Unit 2: Quadratic forms in normal variables, distribution of quadratic forms, Fisher- Cochran theorem and its applications. Wishart distribution, characteristic function of Wishart distribution, additive property, generalized variance and its variance, Wishart matrix and related distributions, Distribution of sample dispersion matrix.

Unit 3: The Mahalanobi's D^2 and Hotteling's T^2 statistics and their uses. Likelihood Ratio Criterion for testing independence of sets of variates, proportionality of covariance matrix, significance of a mean vector, equality of mean vectors and covariance matrices, Fisher Behren problem and sphericity test. Canonical correlation.

Unit 4: The problem of classification, case of two normal populations with parameters known and unknown, Discriminant function, Principal components and their estimation. Basic ideas of cluster and factor analysis.

Books for Study

1. Anderson, T W (2003): Introduction to multivariate analysis, JW,
2. Hair, Anderson, Tatham and Black (2005): Multivariate data Analysis. Pearson Education Society.
3. Rao C R (2002) : Linear statistical inference. JW
4. Srivastava M S (2002): Methods of Multivariate Statistics, JW

Books for Reference

1. Johnson, R.A. & Wichern,, D.W. (1988): Applied Multivariate Statistical Analysis, Prentice Hall Inc.
2. Johnson,S. & Kotz: Continuous Multivariate Distributions,
3. Kshirsagar, A. M. (1983): Multivariate Analysis, Marcel Dekker.
4. Morrison, D M : Multivariate Statistical Methods.

DSS-C210 Design of Experiments (Total credits 3)

Unit 1: The fixed, random and mixed models. The single and two factor ANOVA. Review of standard designs– CRD, RBD, LSD, Analysis of covariance in RBD. Missing plot analysis.

Unit 2: Factorial experiments – 2^n, 3^n and P^n experiments, total and partial confounding in symmetrical factorial designs. Concept of fractional replication

Unit 3: Split plot strip plot designs, Youden square, BIBD PBIBD with only two associate classes, Intra and Inter block analysis of BIBD.

Unit 4: Connectedness and orthogonality of designs. Response surface designs, first and second order designs, ANOVA and tests for lack of fit. Optimality criteria for experimental design,

Books for Study

1. Das, M.N.& Giri,N.C(2008): Design & Analysis of Experiments. New Age
2. Douglas, G. Montgomery (2001): Design & Analysis of Experiments. JW
3. Gupta & Kapoor (2010) Fundamentals of Applied Statistics. Sultha Chand & Co
4. Parimal Mukopadhyay (2005): Applied Statistics, Allied.

Books for Reference

1. Box G. E P Hunter, William (2005): Statistics for Experimental Design, Innovations and Discovery, Vol. II, Wiley
2. Cochran, W.G. & Cox, G.M (2003) : Experimental Designs,Wiley.
3. Fedrer W.T.: Experimental Design- Theory & Applications.
4. Giri .N: Analysis of variance.
5. Hinkelmann, Klaus, Ed (2012): Design and Analysis of experiments-special Designs &

Applications, Wiley.

Semester III

DSS-C311 Stochastic Processes (Total credits 4)

Unit 1: Introduction to Stochastic Processes, time and state space, classification of stochastic processes, distributions with examples, Processes with stationary independent increments, Markov Processes, Martingales, Wiener Processes, Gaussian processes (definitions and examples), Random walk and gambler's ruin problem.

Unit 2: Markov Chains, transition probabilities, Chapman Kolmogorov equations, classification of states, stationary distributions, absorption probabilities, occupation times and ergodic chains.

Unit 3: Renewal process, Branching processes, offspring distribution and probability of extinction, discrete case only.

Unit 4: Continuous time Markov process: Poisson Process, Postulates, characteristics and properties, conditional distribution, non homogeneous Poisson process, Birth and death process the Kolmogorov system of equations, limiting characteristics.

Books for Study

1. Bhat U N, G K Miller (2002): Elements of Applied Stochastic Processes. New Age
2. Feller, W.(1993): An Introduction to Probability Theory and its Applications, Vil. I, New Age.
3. Medhi, J (1982): Stochastic Processes, New Age
4. Ross, S.M. (2007): Introduction to Probability Models, Academic Press

Books for Reference

1. Bhat B R (2004): Stochastic models Analysis and Applications, New Age
2. Cinlar : Introduction to Stochastic Processes.
3. Karlin, S. and Taylor, H M. (1975): A First Course in Stochastic Processes, Academic Press.

DSS-C312 Operations Research(Total credits 3)

Unit 1: Description of a general optimization problem and its characteristics- objective function, constraints, decision surfaces. Major types of Optimization problems with simple examples. Classical optimization methods, local and global optimum, concave and convex functions.

Unit 2: Optimization with and without constraints, functions of several variables with equality constraints, the Lagrange method. The search and descent methods of optimization -general case only, One dimensional Optimization methods-the Fibonacci search method.

Unit 3: Linear programming problem- The geometry of the LPP, two phase simplex, big-M and dual simplex methods. Integer linear programming, Gomory cut method, branch and bound method.

Unit 4: Stochastic programming, Network Analysis, Monte Carlo Simulation and its applications.

Books for Study

1. Kanti Swarup, Gupta, Manmohan , (2008): Operations Research, Sulthan Chand &Sons
2. Mittal and Mohan (2008): Optimization Methods in Operations Research and Systems Analysis, New Age.
3. Rao, SS. (2013): Engineering Optimization Techniques, Theory and practice New Age
4. Taha, H.A.(1992): Operations Research, 5th ed. Macmillan.

Books for Reference:

1. Kambo, N.S.(1991): Mathematical Programming Techniques, Affiliated EastWest Press.
2. Ravindran, A., Philips, D T. and Solberg, J J. (1987): Operations Research Principles and Practice, John Wiley.
3. Suresh Chandra, Jayadev, Aparna(2009):Numerical optimization with application, Narosa.

DSS C313 Time series and Queuing Theory(Total credit 3)

Unit 1: Time series and its components, estimation and elimination of trend and seasonal components test for the noise sequence. Stationary time series and its autocorrelation. Forecasting stationary time series.

Unit 2: The moving average and autoregressive processes ARMA model and its characteristics. Forecasting with ARMA model. Methods of estimation of the parameters of the ARMA model,

Unit 3: Non-stationary ARIMA models and forecasting. Regression with ARIMA model, multivariate time series models.

Unit 4: Queuing system, Markovian Queues- M/M/1, M/M/C, M/Ek/1 and M/G/1 stationary characteristics.

Books for Study

1. Anderson T W (1994) statistical analysis of Time Series, J W
2. Brokewell, P J and Davis R A. (2002): Introduction to Time Series and Forecasting, Springer.
3. Chatfield, C. (1989): The Analysis of Time Series- An Introduction, Chapman.
4. Kanti Swarup, Gupta, Manmohan , (2008): Operations Research, Sulthan Chand &Sons

Books for Reference

1. Box, G EP, Jenkins, (2008): Time series Analysis, forecasting & control, Wiley.
2. Brokewell, P J. and Davis, R A. (1987): Time Series: Theory and Methods,
3. Gross & Harris(2004) Fundamentals of Queuing Theory, J W
4. Peter Bloomfield (2000) Fourier Analysis of Time Series, Wiley
5. Shumway (2008) Time Series Analysis and its applications with R Examples, Springer.

DSS-C414 Statistical Computing With R(Total credits 4)

Unit1: Data Exploration and simple tests, Bayesian estimators, simulation

Unit 2: Analysis of variance and standard design, Factorial design. Simple and Multiple Linear Regression model.

Unit 3 Random sample selections, estimation of mean proportion, variance, confidence interval and efficiency SRS, Stratified random sampling, Various kinds of allocation, Post stratification , estimators based on Ratio and regression methods pps sampling, Two stage sampling, and Systematic sampling.

Unit 4: Sampling from multivariate normal distribution, Wishart matrix, generalized variance, Applications of Hotelling's T^2 and Mahalanobis D^2. Discriminant Analysis, canonical correlation., Meta analysis, Principal component and Cluster analysis, Time series models.

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Books for Reference

1. Dennis B(2013): The R student companion,CRC.
2. Internet Recourses on R software www.CRAN.
3. Muraay Logan (2010) : Biostatistical design and analysis using R, Wiley Black well.
4. Purohit,S G, Ghore S D and Deshmukh S R (2004): Statistics Using R. Narosa
5. Shumway (2008) Time Series Analysis and its applications with R Examples, Springer.

DSS-C415 DATA Analysis Using SPSS(Total credits 4)

Unit1: Data Exploration using Descriptive statistics Procedure, Compare means Procedure & Graphs procedure.

Unit 2: General Linear model Procedure, Generalized linear model Procedure

Unit 3 :Correlate Procedure, Regression Procedure, Loglinear Procedure,

Unit 4 :Classify Procedure, Factor analysis Procedure, Nonparametric tests Procedure, Survival Procedure, Forecasting.

Books for Reference

1. Andy Field.(2011); Discovering Statistics Using SPSS, Sage Publications.
2. Hinton P R, Brownlow C, McMurray,I. and Cozens, B. (2004) SPSS Explained, Routledge, Taylor and Francis group, NY
3. Internet Recourses on SPSS software.www.SPSS.Inc
4. Sabine Landau and Brain S Everitt: A Handbook of Statistical Analysis using SPSS, Chapman and Hall.

The Detailed Syllabus Elective Courses

EL01 Actuarial Methods & Insurance

Unit 1: Investment: Financial institutions, intermediaries and their functions. Cash instruments and their risk characteristics. Investments in bonds and real estates, risk and derivatives. Assets returns and liabilities. Foreign currency investments. Utility and risk measures. Value at risk tail loss, coherent measures.

Unit 2: Life Insurance: Fundamental features, participatory and non participatory life insurance. Distribution of profits – dividends and bonus. Solvency and its effects on emergence of profits. Life office risk and risk management.

Unit 3: General Insurance: Fundamental features, premium rating and claims, experience ratings, reinsurance, stop-loss and reserving.

Unit 4: Pensions: Different types of pension plans and their features, Defined benefits plans and their investment strategies, Individual pension choices. Health insurance.

Recommended Books:

1. Atkinson, M E. and Dickson, DCM. (2000): An Introduction to Actuarial Studies Elgar Publishing.
2. Bedford, T. and Cooke, R. (2001): Probabilistic Risk Analysis, Cambridge
3. Booth P, Chadburn R, Haberman S, James D, Khorasanee Z,Plumb R H and Rickayzen B (2004) Modern Actuarial Theory and Practice 2nd edn CRC Press.
4. Bowers, N.L. Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J. (1997): Actuarial Mathematics (2nded), Society of Actuaries.
5. Daykin C.D., Pentikainen, T. and Pesonen, M. (1994): Practical Risk Theory for Actuaries, Chapman & Hall,.
6. Klugman, S.A. Panjer, H.H.and Willmot, G.E. (2008): Loss Models: From Data to Decisions, John Wiley & Sons.
7. Medina, P K. and Merino, S. (2003): A Discrete Introduction: Mathematical Finance and Probability, Birkhauser
8. Rolski, T., Schmidli, H., Schmidt, V. and Teugels, J.(1998): Stochastic Process for Insurance and Finance. Wiley

EL02 Actuarial Models

Unit 1: Actuarial modeling: Principles and characteristics of actuarial models, Distributional functions used in actuarial measurements. Continuous and discrete models, truncated and modified models, Limiting and extreme value models, Poisson and the (a,b,0) class models,

Compound and mixture models. Multivariate models, dependency, copulas, deductibles, coinsurance and their impacts.

Unit 2: Loss models: Individual risk models, aggregate claims models and computation of their characteristics, recursive, inversion, approximations and empirical methods. Discrete time and continuous time ruin models.

Unit 3: Empirical Models: methods of construction –estimation for complete and modified data, kernel density estimation, approximation for large data sets. Standard methods of estimation of parameters in the models.

Unit 4: Model selection : Adjusted estimates –interpolation and smoothing, credibility estimation. Use of simulation in actuarial modeling.

Recommended Books:

1. Bowers, N.L. H.U. Gerber, J.C. Hickman, D.A. Jones, and C.J. Nesbitt, (1997): Actuarial Mathematics (2nd ed), Society of Actuaries.
2. Grimmett, and D. Stirzaker, (2001): Probability and Random Processes, (3rd ed), Oxford University Press, Oxford,
3. Klugman, S.A. Panjer, H.H.and Willmot, G.E. (2008): Loss Models: From Data to Decisions, John Wiley & Sons.
4. Kulkarni V.G. (1999): Modeling, Analysis, Design, and Control of Stochastic Systems, Springer.
1. Marubini, and M.G. Valsecchi (1995): Analysing Survival Data from Clinical Trials and Observational Studies, John Wiley & Sons.
2. Rolski,T. Schmidt, H, Schmidt,V and Teugels,J. (1998) StochasticProcesses for Insurance and Finance, Wiley

EL03 Advanced Multivariate Analysis

Unit 1: Canonical variables and correlation. Estimation and testing. Cluster analysis.

Unit 2: Factor analysis. Estimation of fixed and random factors and their interpretations.

Unit 3: Conjoint Analysis and its managerial applications. Multidimensional scaling and correspondence analysis. Nonparametric and robust methods of multivariate analysis.

Unit 4: Concepts of Data mining and Neural networks.

Recommended Books:

1. Anderson T W(1984): Introduction to multivariate analysis, J Wiley.
2. Giri, NC (1997): Multivariate Statistical Inference, Academic Press
3. Hair,Anderson, Tatham and Black(2004): Multivariate data Analysis. Pearson Education, Pvt. ltd., India
4. Johnson RA and Wichern D W (2001): Applied Multivariate Statistical Analysis, PHI
5. Morrison, D.F.(1990) Multivariate Statistical Methods, McGraw Hill (3rd ed.)
6. Rao C R : Linear statistical inference.

EL04 Advanced Probability

Unit 1: Stable and infinitely divisible distributions. The General convergence theorems- the degenerate, Poisson and normal convergence theorems (without proof) and their applications.

Unit 2: Product space and product measure space. Sections and their measurability. Fubini's theorem and its applications. Conditional probability - relevant measure theoretic development.

Unit 3: Theory of martingales: Discrete parameter martingales with various applications including U-statistics. Path properties of continuous parameter martingales Central limit theorem for martingale.

Unit 4: Families of probability distributions: compound and mixture distributions, Pearson, Burr and GLD families, Orthogonal polynomials and Cornish Fisher expansions.

Recommended Books:

1. Bhat, B. R. (1985): Modern Probability Theory, Wiley Eastern.
2. Billingsley, P. (1986): Probability and Measure, John Wiley and Sons.

3. Feller, W. (1969): Introduction to Probability and its Applications vol.II,Wiley Eastern.
4. Johnson and Kotz: Continuous Univariate Distributions, Vol. 1, John Wiley
5. Karian, Z. A. & Dudewicz, E. J(2000): Fitting of Statistical Distributions to Data-The Generalized Lambda Distribution and Generalized Bootstrap Methods, CRC Press
6. Kendall, M.G. and Stuart, A. : The Advanced Theory of Statistics, Vol-1,.
7. Loeve, M. (1978): Probability Theory, (4th Edn), Springer Verlag.
8. Ord, J K. (1972): Families of Frequency Distributions.

EL05 Advanced Sampling Theory

Unit 1: Element sampling procedures and estimation- the Bernouli, Poisson and different form of PPS samplings Estimators and their variances, Taylor linearization technique for variance estimation. Difference, Regression and ratio estimators. Estimator for domains.
Unit 2: Errors in surveys and their measurements. Non-response and its measurement estimation by response modeling.
Unit 3: Re-sampling techniques and Variance Estimation – the random group, balanced half sample, Jack-Knife and Bootstrap methods.
Unit 4: Nested models , estimation of variance components and testing, the case of negative variance components. Randomized response technique, small area estimation, synthetic estimation.

Recommended Books:

1. Chaudhari, A. and Stenger, H. (2005) Survey Sampling Theory and Methods, Chapman & Hall
2. Cochran.W.G: Sampling Techniques, J Wiley.
3. Davison, A.C. and Hinkley, D.V. (1997): Bootstrap Methods and Their Applications, Chapman and Hall.
4. Des, Raj and Chandhok, P. (1998): Sample Survey Theory (Narosa)
5. Parimal Mukopadhyay: Theory & Methods of Survey Sampling, PHI
6. Sarndal, C E., Swensson, B and Wretman, J (1992): Model Assisted Survey Sampling, Springer.
7. Shao J. and Tu, D. (1995); The Jackknife and the Bootstrap Methods. Springer Verlag.
8. Som.K.K: Practical Sampling Technique.
9. Thompson, S K.(2000): Sampling, J Wiley

EL06 Advanced Stochastic Processes

Unit 1: Stochastic Processes (General Theory) : Probability spaces appropriate for stochastic processes, Kolmogorov's extension theorem. (only sketch of the proof), separability, progressive measurability and strong Markov property of stochastic processes. The Kolmogorov system of forward and backward equations and the method of their solution and Applications.
Unit 2: Recurrent events and Renewal process, renewal function and equation. Renewal theorems. Markov renewal, regenerative and semi Markov processes renewal reward process.
Unit 3: Diffusion Processes : Definition, Elementary properties, infinitesimal parameters, standard process and Dynkin's theorem, Continuity and non-differentiability of Diffusion processes. Modeling based on Diffusion processes, Standard Brownian Motion, Ornstein-Ulhenbeck process and other processes, stationary distribution of a diffusion process.
Unit 4: Inference on stochastic process. Inference on Markov chains, estimation of transition probabilities and testing for order of Markov chain. Markov sequences –estimation based on likelihood.

Books Recommended:

1. Bhat, B.R.(2000): Stochastic models : Analysis and Applications, New Age
2. Bhat U N: Elements of Applied Stochastic Processes.

3. Karlin, S. and Taylor, H M.: A First Course in Stochastic Processes, Academic Press.
4. Karlin S and Taylor H M: A Second Course in Stochastic Processes, Academic Press.
5. J Medhi: Stochastic Processes, New Age
6. Prakasa Rao, B.L.S. and Bhat, B.R.(1996): Stochastic Processes and Statistical Inference, New Age
7. Ross, S. M (2004): Introduction to Probability Models, Academic Press

EL07 Analysis of Clinical Trials

Unit 1: Introduction to clinical trails: the need and ethics of clinical trials, bias and random error in clinical studies, Protocols, conduct of clinical trials, overview of Phase I-IV trials, Data management-data definitions, standard operating procedure, informed consent form, case report forms, database design, data collection systems for good clinical practice.

Unit 2: Design of clinical trials- Different phases, Comparative and controlled trials, Random allocation, Blinding, Parallel group designs, Crossover designs, Symmetric designs, Adaptive designs, Group sequential designs, Zelen's designs, design of bio-equivalence trials. Outcome measures.

Unit 3: Sample size determination, Surrogate endpoints-selection and design of trials with surrogate endpoints, analysis of surrogate endpoint data. Reporting and analysis-Interpretation of result, multi-center trials

Unit 4: Meta-analysis of clinical trials. Bioassay- Direct and indirect assays, Quantal and quantitative assays, Parallel line and slope ratio assays, Design of bioassays.

Books Recommended:

1. Das & Giri (2008) Design of Experiments, New Age
2. Fleiss, J. L. (1989): The Design and Analysis of Clinical Experiments, Wiley.
3. Friedman, L. M., Furburg, C. D. Demets, L. (1998): Fundamentals of Clinical Trials, Springer Verlag.
4. Jennison and B. W. Turnbull (1999): Group Sequential Methods with Applications to Clinical Trails, CRC Press.
5. Kulinskaya E, Morgeathaler S, Staudte RG (2008),Meta analysis,Wiley.
6. Marubeni,E. and M. G. Valsecchi (1994): Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.
7. Piantadosi S. (1997): Clinical Trials: A Methodological Perspective. Wiley.

EL08 Analysis of Discrete and Longitudinal Data

Unit 1: Discrete data and their measures, Inference for contingency tables, Logistic models, statistical power and sample size computations Logit models with categorical predictors, logit models with multi responses-nominal and ordinal responses.

Unit 2: Log-linear models for 2-way and 3 way contingency tables and their extensions.
Models for matched pairs.

Unit 3: Longitudinal data and their characteristics. The general linear model for Longitudinal data: ML and REML estimation, EM algorithm, general linear mixed effects model. Inference for the random effects. BLUPs, Empirical Bayes, Shrinkage model building and diagnostics, generalized additive mixed model.

Unit 4: Generalized Linear Model for longitudinal data, random effect models, Transition models, Likelihood models for categorical data, Poisson and Logistic regression models. Analysis and tests. Classification of missing data mechanisms-intermittent missing values and dropouts, Weighted estimating equations, Modeling the dropout process.

Books Recommended:

1. Agresti, A(2002): Categorical Data Analysis,Wiley.
2. Davidian,M. and Giltinan,D.M. (1985): Nonlinear Models for Repeated Measurement Data, CRC Press.

3. Diggle, PJ. Heagerty, P. Liang, KY. and Zeger, SL. (2003): Analysis of Longitudinal Data, Oxford university Press.
4. Hand D. and Crowder, M. (1996): Practical Longitudinal Data Analysis, CRC Press.
5. Indrayan A(2013): Medical Bio Statistics, CRC.
6. Kariya T, Karata H (2004): Generalized least squares, Wiley.
7. Lindsey, J K.. (1993): Models for Repeated Measurements, Oxford.
8. McCullagh P. and J.Nelder (1989): Generalized Linear Models, CRC Press.
9. Simonoff J (2003) :Analyzing categorical data, Springer.

EL09 Bayesian Econometrics & Game Theory

Unit 1: Introduction to Bayesian Econometrics, Bayes theorem, prior probability density functions, Bayes estimates of parameters and prediction. Income and allied size distributions, Stochastic models of income distribution, Measurement of income inequality, problems of measurement, Indian studies on inequality and poverty.
Unit 2: Advanced demand analysis-Demand systems, zero expenditure and corner solutions, nonlinear budget frontiers, rationing, sources of dynamics in consumer behaviour, durable goods, non-parametric demand analysis.
Unit 3: Games of Incomplete Information, Bayes-Nash equilibrium. Applications to industrial organization. Reputation models. Auction theory, First and second price auctions. The Revenue Equivalence Theorem. Revenue optimal auctions in the independent values case. Efficient auctions in the common-values case. The theory of equilibrium selection, Sequential and trembling hand perfect equilibria, Forward induction. Mechanism Design
Unit 4: Bayesian Incentive compatibility, Topics in evolutionary game theory, Advanced topics in cooperative games.
Books Recommended:

1. Koop Gary : Bayesian Econometrics.
2. Wold, H. &.Jureen, L : Demand Analysis – A Study in Econometrics.
3. Zellner, A. : An Introduction to Bayesian Inference in Econometrics.

EL10 Data Structures & Programming in R

Unit 1: Computer representation of data and arithmetic. Sources and propagation of errors. Bit manipulations, operators, fields and files. Data Structures: definitions, operations, implementations and applications of basic data structures. Array, stack, queue, dequeue, priority queue, doubly linked list, orthogonal list, dynamic storage management, sparse matrix.
Unit 2: Binary trees and their representation, traversal algorithm, threaded binary tree, generalized list.Binary search, Fibonacci search, binary search tree, height balance tree, heap, B-tree, digital search tree, hashing techniques.
Unit 3: Programming in R
Unit 4: Numerical integration, differentiation, interpolation and solving equations. Generation of random numbers, Simulation and their applications.
Books Recommended:

1. Aho, A. Hopcroft, J. and Ullman, J.: Data Structures and Algorithms.
2. Internet Resources in R.
3. Knuth, D E. (2002): The Art of Computer Programming, Vol.2, Pearson Education.
4. Mohanan, J F. (2001): Numerical Methods of Statistics, Cambridge
5. Ross, S M. (2002): Simulation, Academic press.
6. Standish, T.A.: Data Structure Techniques.
7. Tenenbaum, Aaron M, Langsam, Yedidyah Augenstein, M J. (1994): Data Structures Using C, PHI.

EL11 Demography

Unit 1: Demography- evolution, concept and scope. Post Malthusian theories of population, Demographic transitions. Demographic rates ratios. Measurement of Mortality and Fertility. Various types of Life Tables and applications - Uses of Life Table approach in Demography.
Unit 2: : Structure of Population- Lotka's stable population theory: concepts, assumptions and properties. Stationery and quasi-stable population. Population estimation and projection. Population Growth- Exponential, Logistic- Different methods of population estimation and projection- Mathematical and component methods.
Unit 3 Stochastic models for population changes- Pure Birth and Death Process- Birth, Death, Migration models- Markov Chain- Renewal Process- Mortality Models- Model Life Tables- UN, Coale & Demeny, Leaderman's System, Brass Logit system, UN Tables for Developing countries-Stable population models.
Unit 4: Population and Development- Relationship between population and development- Human Development- Measures of Human Development- Human development Index- computation-Human Poverty Index. Indian Population policy.
Recommended Books:

1. Asha A Bhende and Tara Kanitkar: Population Studies (5th Revised Edition), Himalaya Publishing House, New Delhi.
2. Biswas, S. (1988): Stochastic Processes in Demography and Applications, New Age.
3. Henry, S. Shryock, and Jacob, S. Seigel, (1976): - Methods and Materials of Demography; Academic Press, New York.
4. Krishnan Namboodiri and C.M Suchindran (1987): Life Table Techniques and their Applications, Academic Press, London
5. Ramkumar, R. and Gopal. YS. (1986): Technical Demography; Wiley Eastern
6. Saxena, P C and Talwar P P (1987): Recent Advances in the Techniques for Demographic Analysis; Himalaya Publishing House.
7. K. Srinivasan (1998): Basic Demographic Techniques and Applications; Sage Publications, New Delhi.
8. Srivastava, S C. (2004): Studies in Demography, Anmol publications,New Delhi
9. UNDP (2003). Human Development Report.

EL12 Econometrics Methods

Unit 1: Discrete and Limited Dependent Variables Model: types of discrete choice models, linear probability model, the probit and the logit models and Tobit model. Analysis of Panel Data: Fixed effects model, random effects model Wu-Hausman test, Swamy's random coefficient model.
Unit 2: The general linear regression model and assumptions. Autocorrelation and its tests, multicollinearity and prediction. Specification testing and Diagnostic Checking: inferential problems in misspecified or inadequately specified models; tests based on ML principle . WLR and Rao's (RS) tests; White's information matrix test; tests for non-nested hypothesis. Davidson and McKinnon's J test and the encompassing test.
Unit 3: Simultaneous equation models and methods; structural and reduced forms, indirect and two stage least squares, bias problems; identification and estimation.
Unit 4: Basics of non-parametric regression, idea of smoothing, smoothing techniques, the kernel method and choosing the smoothing parameter.
Books Recommended:

1. Belsley, D.A. Kuh, E. and Welsch : Regression Diagnostics: Identifying Influential Data and Sources of Collinearity
2. Cook R.D. & Weisberg : Residual and its Influence in Regression
3. Draper N.R. & Smith H.: Applied Regression Analysis
4. Green, P J and Silverman, B W: Nonparametric Regression and Generalized Linear Models

5. Hardle, W. : Applied Nonparametric Regression
6. Hastie, T.and Tibshirani : Generalized Additive Models
7. Horowitz, J.L. : Semi parametric Methods in Econometrics
8. Johnston, J. and DiNardo, J. : Econometric Methods
9. McCullagh, P. and Nelder, J. : Generalized Linear Models
10. Simonoff, J.S : Smoothing Methods in Statistics
11. K. Takezawa : Introduction to Nonparametric Regression
12. William H. Greene : Econometric Analysis

EL13 Economic Development & Growth Models

Unit 1: The Dual Economy: Surplus Labour, Wage Rigidity and Unemployment Underdevelopment as a Path Dependant Process: Vicious Circles, Balanced vs. Unbalanced Growth and Big Push Theory.

Unit 2: Growth, Development and Income Distribution Rural Markets and Institutions

Unit 3: Review of traditional growth models, efficiency results, barriersto growth, technical progress. AK models of growth. Education and growth. Market structure and innovation. Obsolescence, Schumpeterian growth. Distribution and Political Economy of growth. Open growing economies, trade policies.

Unit 4: Income and allied size distributions : Stochastic models of income distribution, Measurement of income inequality, problems of measurement, Indian studies on inequality and poverty. Advanced demand analysis : Demand systems, zero expenditure and corner solutions, nonlinear budget frontiers, rationing, sources of dynamics in consumer behaviour, durable goods, non-parametric demand analysis.

Books Recommended:

1. Chaubey Y. P. : Poverty Measurements: Issues, Approaches and Indices
2. Keyfitz N. : Applied Mathematical Demography
3. Nerlove M. : Estimation and Identification of Cobb-Douglas Models
4. Sen A. : Poverty and Inequality
5. Wold H. & Jureen L. : Demand analysis – A Study in Econometrics

EL14 Industrial Quality Control

Unit 1: The concepts of statistical Quality improvement in industry. Modeling process quality. Statistical Process control and different types of control charts control chart for short run process, group control chart, EWMA and CUSUM chart, modified control chart, R&R study, Bayesian Control charts.

Unit 2: General ideas on economic designing of control charts. Duncon's model for the economic control chart. Capable process, capability & performance indices, C_p, C_{pk} for bilateral & unilateral quality characteristics. Estimation & confidence intervals for estimators of C_p. Capability of series system. Connection between proportion of defectives & C_p.

Unit 3: Acceptance sampling plan for variables with single & double specification limits. Designing variable acceptance sampling plans. AQL based sampling plans. Continuous sampling plans CSP-I & CSP – II. Bayesian sampling plans.

Unit 4: Management of Quality Control : Concepts of quality planning, control, assurance and improvement, Elements of quality management system, TQC, TQM quality circle, system standards, organization of six-sigma programmes in the industry. Role of statistical techniques in quality management.

Books Recommended:

1. Duncan, A J (1986): Quality Control and Industrial Statistics.
2. Grant E L and Leaven Worth, R S. (1980): Statistical Quality Control, McGraw Hill.
3. Mittag, H J and Rinne, H. (1993): Statistical Methods for Quality Assurance, Chapman and Hall.

4. Montgomery, D. C. (2004): Introduction to Statistical Quality Control, Wiley
5. Oakland, J S. and Follorwel, RF. (1990): Statistical Process Control , East west Press
6. Schilling, E G (1982): Acceptance Sampling in Quality Control, Marcel Decker.

EL15 Knowledge Discovery & Data Mining

Unit 1: Review of classification methods from multivariate analysis; classification and decision trees. Clustering methods from both statistical and data mining viewpoints; vector quantization.

Unit 2: Unsupervised learning from univariate and multivariate data; Dimension reduction and feature selection. Supervised learning from moderate to high dimensional input spaces;

Unit 3: Artificial neural networks and extensions of regression models, regression trees.

Unit 4: Introduction to databases, including simple relational databases; data warehouses and introduction to online analytical data processing. Association rules and prediction; data attributes, applications to electronic commerce.

Books Recommended:

1. Berson, A. and Smith, S.J. (1997): Data Warehousing, Data Mining, and OLAP. McGraw-Hill.
2. Breiman, L., Friedman, J.H., Olshen, R.A. and Stone, C.J. (1984): Classification and Regression Trees, Wadsworth and Brooks/Cole.
3. Han,J. and Kamber.M. (2000): Data Mining; Concepts and Techniques. Morgan Kaufmann.
4. Mitchell, T.M. (1997). Machine Learning. McGraw-Hill.
5. Ripley, B.D. (1996). Pattern Recognition and Neural Networks. Cambridge University Press.

EL16 Life Contingencies

Unit 1: Mortality analysis and models, Population growth, composition and distribution, Projection models, Stable population theory, Life tables and its relation with survival function, force of mortality, various conditional probabilities from ultimate and select life tables, monthly payments, inter-relations of various types of payments. Calculation of various probabilities from life tables, approximations, select and ultimate tables, alternatives to life tables.Calculation of various payments from life tables: principle of equivalence, net premiums, prospective and retrospective provisions/reserves, recursive relations, Thiele's equation, actual and expected death strain, mortality profit/loss.

Unit 2: Assurance and annuity contracts: definitions of benefits and premiums, various types of assurances and annuities, present value, formulae for mean and variance of various continuous and discrete payments,Adjustment of net premium/net premium provisions for increasing/decreasing benefits and annuities, calculations with ultimate or select mortality, with-profits contract and allied bonus, net premium provision. Gross premiums-Various expenses, role of inflation, future loss and equivalence principle, alternative principles, calculation of gross premium provisions, gross premium retrospective provisions, recursive relations.

Unit 3: Functions of two lives: cash-flows contingent on death/survival of either or both of two lives, functions dependent on a fixed term and on age. Cash-flow models for competing risks-Markov model, dependent probability calculations from Kolmogorov equations, transition intensities. Use of discounted emerging costs in pricing, reserving and assessing profitability: unit-linked contract, expected cash flows for various assurances and annuities, profit tests and profit vector, profit signature, net present value and profit margin, use of profit test in product pricing and determining provisions, multiple decrement tables, cash-flows contingent on multiple decrement, alternatives to multiple decrement tables, cash-flows contingent on non-human life risks.

Unit 4: Heterogeneity in mortality: contributing factors, main forms of selection, selection in insurance contracts and pension schemes, selective effects of decrements, risk classification in

insurance, role of genetic information, single figure index, crude index, direct/indirect standardization, standardized mortality/morbidity ratio (SMR). Cost of guarantees: types of guarantees and options for long term insurance contracts, calculation through option-pricing and stochastic simulation.

1. P.M. Booth, R.G. Chadburn, D.R. Cooper, S. Haberman and D.E. James, (1999): Modern Actuarial Theory and Practice, Chapman & Hall.
2. N.L. Bowers, H.U. Gerber, J.C. Hickman, D.A. Jones, and C.J. Nesbitt (1997): Actuarial Mathematics (2nd ed), Society of Actuaries,
3. B. Benjamin and J.H. Pollard 1993 The Analysis of Mortality and Other Actuarial Statistics, 3rd ed., Institute of Actuaries and Faculty of Actuaries,.
4. Neill, Heinemann, (1977):Life Contingencies.

EL17 Queues and Inventories

Unit1: The Queuing process. Markovian queuing models, Queues with constraints and special features, Tandem queues. Semi-Markovian queuing systems, with service vacations, Batch arrivals and bulk queues.

Unit 2 Models with general arrival and/or service patterns. Simulation The notion of queuing network. Jackson and Kelly networks. The use of queuing network in manufacturing systems

Unit 3: Inventory models: Deterministic models and the EOQ formula, Stochastic inventory models, the newsboy model, the (Q,r) and (s,S) models.

Unit 4: Concepts of supply-chain management. Replacement problems- Replacement of items that fail gradually and stochastically. The use of renewal theory in comparing replacement policies.

Books Recommended:

1. Kambo, N.S.(1991): Mathematical Programming Techniques, Affiliated East-West Press Pvt.Ltd.
2. Mittal and Mohan (1990): Optimization Methods in Operations Research and Systems Analysis.
3. S S Rao (2000): Optimization techniques, New Age.
4. Ravindran, A., Philips, D T and Solberg, J J. (1987): Operations Research principles and practice, John Wiley.
5. Taha, H.A.(1992): Operations Research 5th ed. Macmillan.

EL18 Statistical Ecology & Genetics

Unit 1: Population Dynamics: One species - exponential, logistic and Gompertz models. Two species - competition, coexistence, predator - prey oscillation, Lotka - Volterra equations, isoclines. Leslie matrix model for age structured populations. Survivorship curves - constant hazard rate, monotone hazard rate and bath-tub shaped hazard rates.

Unit 2: Population density estimation -Capture- recapture models, nearest neighbor models, line transect sampling. Ecological Diversity - Simpson's index, Shannon – Weaver index, Diversity as average rarity. Optimal Harvesting of Natural Resources, Maximum sustainable yield, tragedy of the commons.

Unit 3: Statistical problems in human genetics, blood group analysis. Natural selection. Quantitative genetics, study of inheritance of quantitative characters in random and nonrandom mating diploid populations. Detection and estimation of linkage. Gene frequency, random mating, Hardy-Weinberg Equilibrium, Matrix theory of random mating with applications.

Unit 4: Sequence similarity, homology and alignment. Algorithm for pair and multiple sequence alignments, construction of phylogenetic trees, UPGMA. Neighbor joining, maximum parsimony and maximum likelihood algorithms.

Books Recommended:

1. Clark, C.W.(1976): Mathematical Bio-Economics : The Optimal Management of Renewable Resources, Wiley.
2. Gore A.P. and Paranjpe S.A.(2000): A Course on Mathematical and Statistical Ecology, Kluwer Academic Publishers.
3. Pielou, E.C.(1977) An Introduction to Mathematical Ecology, Wiley.
4. Seber, G.A.F.(1982): The Estimation of Animal Abundance and Related Parameters 2nd Ed. C.Griffin.

EL19 Statistical Methods in Medical Research

Unit 1. Study designs in epidemiology. Measures of disease occurrence and association, variation and bias. Identifying non-causal association and confounding. Defining and assessing heterogeneity of effects, interaction. Sensitivity and specificity of diagnostic test.
Unit 2: Cohort Study designs, Case-Control study designs, Matched case-control studies ,Cross-over study design.
Unit 3: Statistical mapping and environmental epidemiology, Statistical validation and analysis, Carcinogenic Potency-Cancer, Cardiovascular Risk.
Unit 4: Mendel's laws, Estimation of allele frequencies, Hardy-Weinberg law, Mating tables, Models of natural selection and mutation, Detection and estimation of linkage (recombination), Inheritance of quantitative traits,

Books Recommended:

1. Agersti, A. (1990): Categorical Data Analysis ,JW
2. Indrayan A(2013): Medical Bio Statistics, CRC.
3. James F.jekel,MD,MPH,David L.Katz,MD,MPH,Joann G.Elmore,MD,MPHand Dorothea M.G.Wild,MD,MPH: Epidemiology,Biostatistics
4. Lindsey, J K.. (1993): Models for Repeated Measurements, Oxford.
5. Lloyd C J (1999): Statistical analysis of categorical data, Wiely.
6. Prem Narain(1990):Statistical Genetics, New Age.
7. Selvin : Statistical Analysis of Epidemiological Data.
8. Sen P.K and C.R.Rao (2000), Handbook of Statistics 18,Bioenviornmental and public Health Statistics ,North Holland.
9. Simonoff J (2003) :Analyzing categorical data, Springer.

EL20 Statistical Pattern Recognition

Unit 1: Review of Bayes classification: error probability, error bounds, Bhattacharya bounds, error rates and their estimation,Parametric and nonparametric learning, density estimation, Classification trees; *k*-NN rule and its error rate;
Unit 2: Neural network models for pattern recognition: learning, supervised and unsupervised classification; Unsupervised classification: split/merge techniques, hierarchical clustering algorithms, cluster validity, estimation of mixture distributions; Feature selection: optimal and suboptimal algorithms; Some recent topics like data mining, support vector machines, etc.
Unit3: Introduction, image definition and its representation, Typical IP operations like enhancement, contrast stretching, smoothing and sharpening, grey level thresholding, edge detection, medial axis transform, skeletonization/thinning, warping; Segmentation and pixel classification;
Unit 4; Object recognition; Some statistical (including Bayesian) approaches for the above, like Besag's ICM algorithm, deformable templates approach of Grenander and colleagues, and so on.

Books Recommended:

1. Duda, R.O. and Hart, P.E. (1973): Pattern Recognition and Scene Analysis. Wiley.

2. Fukunaga,K. (1990): Introduction to Statistical Pattern Recognition, 2nd Ed. Academic Press.
3. McLachlan, G.J. (1992): Discriminant Analysis and Statistical Pattern Recognition, Wiley.
4. Ripley, B.D. (1996): Pattern Recognition and Neural Networks, Cambridge University Press.

EL21 Statistical Software- SPSS and R (Total credits 4)

Unit 1: SPSS – SPSS Windows, using Help, drop down menus of SPSS data editor window, dialog boxes, data structure, measurement mode and quality of data. Variables and labels, creating and modifying data files.

Unit 2: Import of data files, Transforming data, selection of random samples, splitting of data file, contingency tables, weight cases. SPSS plots and graphs, labeling and editing graphs.

Unit 3 Objects and their classes, operators, vectors and matrices, list and data frames, indexing and accessing data, Importing and exporting data. common builtin functions Simple applications- Descriptive statistics,

Unit 4: Graphics with R. Selection of representative samples, probability and probability distributions, Sampling distribution of sample mean, estimation of parameters, Plots to check normality, solution of equations, Programming in R-control statements, functions and scripts.

Books Recommended

1. Andy Field.(2011); Discovering Statistics Using SPSS, Sage Publications.
2. Dennis B(2013): The R student companion,CRC.
3. Hinton P R, Brownlow C, McMurray,I. and Cozens, B. (2004) SPSS Explained, Routledge, Taylor and Francis group, NY
4. Internet Recourses on R software .www.CRAN.
5. Internet Recourses on SPSS.
6. Muraay Logan (2010) :Biostatistical design and analysis using R, Wiley Black well.
7. Purohit S G, Ghore S D and Deshmukh S R (2004): Statistics Using R. Narosa
8. Sabine Landau and Brain S Everitt: A Handbook of Statistical Analysis using SPSS, Chapman and Hall.

EL22 Stochastic Epidemiology

Unit 1: Theory of epidemics, simple, general and recurrent epidemics, Discrete-time models, Spatial models, Carrier models, Host - vector and venereal disease models. Competition and predation.

Unit 2: The general birth and death process, the Poisson Process. Stationary behaviour

Unit 3: The Diffusion process, diffusion as a limit of Random walk, as a limit of branching process, Application to population growth.

Unit 4: Population growth models, different methods of projection and forecasting

Books Recommanded:

1. Baily, N T J :The Elements of Stochastic Process with Application to Natural Sciences, John Wiley.
2. Karlin, S. and Taylor, H M. (1975): A First Course in Stochastic Processes, Academic Press.
3. Ross, S.M. (2007): Introduction to Probability Models, Academic Press
4. Bhat U N: Elements of Applied Stochastic Processes,
5. Cinlar : Introduction to Stochastic Processes.
6. Medhi, J: Stochastic Processes, New Age

EL23 Stochastic Models in Finance

Unit 1: Binomial model : One-step and two-step models, Binomial trees. Risk neutral valuation. Behaviour of stock prices : Conditional expectation, Martingale, Markov property, Ito Process, Ito Lemma.

Unit 2: Black Scholes model : Distribution of returns, volatility, Black-Scholes-Merton differential equation. Estimating voloatility.Options on stock indices, currencies and futures. Value at risk.

Unit 3: Time series and its components, estimation and elimination of trend and seasonal components test for the noise sequence. Stationary time series and its autocorrelation. Forecasting stationary time series. The moving average and autoregressive processes ARMA model and its characteristics. Forecasting ARMA model.

Unit 4: Applications of time series analysis, filters, random walks, multivariate AR model, co integrated time series, non-stationary/non-linear models, application to investment variables, forecasts. Assessment of methods through Monte-Carlo simulations.

Books Recommended:

1. Baxter, M.and Rennie, A.L (1996): Financial Calculus, Cambridge,
2. Bingham, N. and Keisel, R.: Risk-Neutral Valuation, Springer.
3. Bowers, N. L. Gerber, H. U. Hickman, J. C. Jones D. A. and C. J. Nesbitt, (1997): Actuarial Mathematics, Society of Actuaries, Itasca, IIIinois, USA Second Edition.
4. Brockwell, P J. and Richard A Davis (2006): Introduction to Time Series and Forecasting, Springer.
5. John Hull L : Options, Futures and Other Derivatives, Prentice Hall.

EL24 Survival Analysis & Bayesian Inference

Unit 1:: Life time models and life time characteristics - continuous and discrete models, mixture models, hazard function, survival function and mean residual life function, Censuring and truncation of distributions. Different censoring schemes. Ageing classes - IFR, IFRA, NBU, NBUE, HNBUE and their duals, Bathtub Failure rate.

Unit 2: Estimation and Testing of the life time characteristics parametric and nonparametric methods. Kaplan - Meier Estimator, Estimation under the assumption of IFR/DFR.Tests of exponentiality against non-parametric classes - Total time on test, Deshpande test. Two sample problem - Gehan Test, Log rank test. Mantel - Haenszel Test, Tarone - Ware tests.

Unit 3 : Parametric regression models of lifetime. Semi-parametric regression for failure rate - Cox's proportional hazards model with one and several covariates. Survival analysis and competing risk, multi variable survival models.

Unit 4 : Bayesian Inference: randomized and non-randomized decision rules, risk and loss function, optimality of decision rules. Estimation, testing hypotheses, confidence interval and prediction under Bayesian approach.

Books Recommended :

1. Alaen O O, Borgen O, Gjessing H K (2008): Survival & Invent history analysis, Springer.
2. Balakrishnan N, C.R.Rao (2001).Hand Book of Statistics Vol 20, Advances in Reliability, North Holland.
3. Bensal A K (2008): Bayesian Parametric Inference, New Age
4. Cox, D.R. and Oakes, D. (1984): Analysis of Survival Data, Chapman and Hall, New York.
5. Elandt - Johnson, R.E. Johnson N.L. (1980): Survival models and Data Analysis, John Wiley and Sons
6. Ghosh J K, Delampady M, Samanta T (2006) : An Introduction to Bayesian Analysis, Springer.
7. Gross A.J. and Clark, V. A. (1975):Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
8. Hosmer D.W, Lemeshow S, May S (2008): Applied Survival Analysis ,Wiely.
9. Lawless, J.F. (2003): Statistical Models and Methods for Life Time, J wiley
10. Sinha S K (1986) reliability and Life testing, Wiley.

Open Courses (Inter disciplinary courses) offered by the Department

DSS-O01 Elementary Statistical Methods (Total credits 3 -Theory 2+Practical 1).
[This course is for those who have to use Statistical techniques for their PG/Research study but have not studied Statistics at the main or subsidiary level for their qualifying examination.]

Unit 1: Data types- nominal, ordinal and scale types. Primary and secondary data. Exploratory Data Analysis-diagrams and graphs, p-p and q-q plots, box plot, scatter plots- interpretations and uses. Measures of central tendency-mean, median, mode, geometric mean, harmonic mean,dispersion, skewness and kurtosis. Simple correlation and regression, Pearson and Spearmans correlation coefficients, interpretation and uses. Measures of association for contingency tables. Numerical computations using R software.
Unit 2: Random experiments and events ,equally likely, and mutually exclusive events, simple and compound events. Classical and frequency concepts of probability, Addition and multiplication theorems, conditional probability and independence, Baye's theorem. Random variable density and distribution functions. Numerical computations using R
Unit 3: Characteristics and properties of uniform, binomial, Poisson, rectangular, exponential and normal distributions. Notion of sampling distributions t, χ^2 and F. Basic concepts of population and sample, parameter and statistics, methods of sample selection simple random sampling, systematic random sampling. Numerical computations using R.
Unit 4:. Basic notions of tests of hypotheses, level of significance and p-value, interpretation of test results. Standard tests based on normal, t, χ^2 and F. Concept of ANOVA. Numerical computations using R

Books recommended:

1. Levin and Rubin (2004) Statistics for management,PHI.
2. S G Purohit, S D Ghore and S R Deshmukh (2004): Statistics Using R. Narosa.
3. Rohatgi V K and Saleh E (2000) An introduction to probability and statistics, Wiley.
4. Trivedi K S (2005) Probability and statistics with reliability, queuing and computer science applications, PHI.

DSS-O02 Data Analysis and Statistical Decision Making (Total credits 3 - theory 2+practical 1). [This course is for Post graduate students and Researchers who have studied mathematics/statistics at subsidiary level for their qualifying examination.]

Unit 1: Exploratory Data Analysis- diagrams and graphs,p-p and q-q plots, box plot, scatter plots- interpretations and uses. Descriptive statistics. Design of a questionnaire. Scientific methods of sampling- srs, systematic cluster, stratified and pps methods. Numerical computations using R or SPSS

Unit 2: Classical and frequency concepts of probability,Addition and multiplication theorems, conditional probability and independence, Bayes theorem and applications. Random variables, density and distribution functions. Characteristics and properties of uniform, binomial, Poisson, geometric hyper geometric, rectangular, exponential, gamma beta and normal distributions and their applications. Generation of random samples from specified distributions. Numerical computations using R or SPSS
Unit 3: Sampling distributions and standard error, Estimation of population characteristics, method of moments, method of maximum likelihood. Confidence interval. Tests of hypotheses, level of significance and p-value, interpretation of test results.Tests based on t, χ^2 and F distributions. Numerical computations using R or SPSS

Unit 4:. Simple correlation and regression, Pearson and Spearmans correlation coefficients, interpretation and uses. Measures of association for contingency tables.. Nonparametric tests. Linear regression models and least squares method. Concept of one way and two way ANOVA. Numerical computations using R or SPSS

Books recommended:

1. Mukhopadhyay (2006) Theory and methods of survey sampling , PHI
2. S G Purohit, S D Ghore and S R Deshmukh (2004): Statistics Using R. Narosa.
3. Rohatgi V K and Saleh E (2000) An introduction to probability and statistics, Wiley.
4. Ross S M (2000) Introduction to probability and statistics for engineers and scientists , AP
5. Trivedi K S (2005) Probability and statistics with reliability , queuing and computer science applications, PHI

DSS-O03 Operations Research (Total credits 3- Theory 2+Practical 1).

[This course is for Post graduates students of Computer Science, Computer Applications, Commerce, Economics, Management Studies and Mathematics and Physics.]

Unit 1: Introduction to operations research problems and procedures of analysis. Linear Programming problem- graphical and simplex solutions, dual simplex problem.

Unit 2: Transportation and assignment problems, job sequencing , project scheduling and network analysis, project evaluation and review technique.

Unit 3: Game theory, Simulation and its applications.

Unit 4: Queuing theory and applications.

Practical in each unit to be done using any of the available software -TORA, R or Matlab.

Books recommended:

1 Kanti Swarup, Gupta P K and Man Mohan (2005) Operations Research, Sulthan Chand & Sons

2 Taha H A (2003) Operations Research, PHI

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