The Addl. Secretary
Chancellor's Secretariat

Raj Bhavan, Pala

12.06.2018

Sub: Recommendations for MA/MSc Statistics CBCS syllabus with modifications

Sir,

Please, find enclosed herewith, the modified MA/MSc syllabus course content for necessary action.

Yours faithfully,

[Signature] 12.06.18

[Signature] 12.06.18

[Signature] 12.06.18

(CM)

(S.K. Singh)
SYLLABUS FOR M. A./M.Sc. IN STATISTICS
UNDER
CHOICE BASED CREDIT SYSTEM (CBCS)
(To be effective from 2018 -19)

UNIVERSITIES OF BIHAR
&
PATNA UNIVERSITY
OUTLINE OF THE CHOICE BASED CREDIT SYSTEM (CBCS) for PG degree courses:

It consists of a number of courses i.e. Core Course (CC), Elective Course (EC), Discipline Specific Elective Course (DSE), Ability Enhancement Courses (AEC), and Ability Enhancement Compulsory Courses (AECC). Each course is equivalent to a paper. The nature of these courses is defined below.

1.1 Core Course (CC):
A course which should compulsorily be studied by a candidate as a core requirement on the basis of subject of MSc studies and is termed as a Core course.

1.2. Elective Course (EC):
Generally a course which can be chosen from a pool of courses (Basket) and which may be very specific or specialized or advanced or supportive to the subject/discipline of study or which provides an extended scope or which enables an exposure to some other subject/discipline/domain or nurtures the candidate’s proficiency/skill is called an Elective Course.

1.3 Discipline Specific Elective Course (DSE):
Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

1.4 Generic Elective (GE) Course:
An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

1.5 Ability Enhancement Courses (AEC):
The Ability Enhancement Courses (AEC) / Skill Enhancement Courses (SEC). “AEC” courses are the courses based upon the content that leads to life skill enhancement.
1.6 Ability Enhancement Compulsory Courses (AECC):

University will run a number of Ability Enhancement Compulsory Courses (AECC) which is qualifying in nature and student from all faculties have to qualify in all such courses.

1.7 Dissertation/Project/ Internship/ Industrial Training/ Field Work:

Elective courses are designed to acquire advanced knowledge to supplement/support the main subject through project work/ internship/ industrial training/ field work. A student studies such a course on his/her own with mentoring support by a teacher / faculty member called the guide/ supervisor. In case of internship/ industrial training the student will work under the joint guidance of one teacher-supervisor from the parent department to be termed as Supervisor-1 and one suitably qualified personnel at the research institute/ research laboratory/ industrial organization, to be termed as Supervisor-2. A student may join any recognized research institute/ research laboratory/ the industrial organization with the approval of parent department. The student has to work for a minimum number of days/ hour as decided by the parent department. On completion of the project work/ training at the research institute/ research laboratory/ industrial organization, student will submit a written project report certified by both supervisors to the parent department. Supervisor-2 will issue a letter certifying that the candidate has successfully completed the project and also award marks/ grade to him/ her. The certificate will be submitted to the parent department confidentially. The Board of Courses of Studies (BOCS) of the concerned subject/ department will draft and design the certificate and other documents as per requirement. The parent department will also assist the students to choose proper organizations for their project work/ industrial training/ field work etc.

2.0 CREDIT

The total minimum credits, required for completing a PG program is 100.

The details of credits for individual components and individual courses are given in Table.2.
### Table 1: Structure of the 2 Yrs (Four Semesters) Post Graduate Degree course under CBCS:

<table>
<thead>
<tr>
<th>Semester</th>
<th>No of COURSE/ Papers</th>
<th>Credit per COURSE/ paper</th>
<th>Total credit</th>
<th>Minimum No of Learning Hours#</th>
<th>No of CORE COURSE/ PAPER</th>
<th>No of ELECTIVE Course/ PAPER</th>
<th>Code &amp; Nature of Elective Course/ paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>05</td>
<td>05</td>
<td>25</td>
<td>250</td>
<td>4</td>
<td>1</td>
<td>AECC-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SEMESTER BREAK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>06</td>
<td>05</td>
<td>30</td>
<td>300</td>
<td>5</td>
<td>1</td>
<td>AEC-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SEMESTER BREAK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>06</td>
<td>05</td>
<td>30</td>
<td>300</td>
<td>5</td>
<td>1</td>
<td>AECC-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SEMESTER BREAK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>03</td>
<td>05</td>
<td>15</td>
<td>150</td>
<td>0</td>
<td>3</td>
<td>EC -1*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EC -2*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DSE-1 or GE-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>20</td>
<td>100</td>
<td>14</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

#For Tutorial (T)/ Practical (P)/ Field Work (FW)/ Internship etc. extra working hour to be added as per requirement and will be decided by the BOCS of the respective subject.

* The two Elective Courses (EC) to be studied in semester IV may be

**Both theory papers**

/ One Theory paper and One Practical paper

/ One Theory paper and One Project work

/ One Theory paper and One Field work

/ Both Project work/ Internship

**IMP**: It is desirable that all students of all courses be given adequate exposure over and above the class room teaching to enhance the scope of skill development/ entrepreneurship and employability.
2.1. There shall be six elective courses - two EC, one DSE or one GE, two AECC, one AEC. Students may opt for any elective course out of a list of elective papers (Basket) offered by the parent department or any other department/s as per his/her choice with the prior permission of the parent department. The list of elective papers, syllabus and prerequisite of the elective course will be as decided by the Board of Courses of Studies (BOCS) of the concerned subject/ department. All elective course listed may not be available in all semesters. Based on the availability of resource persons and infrastructure the parent department will assist the students to select elective courses of their choice.

2.2. The final CGPA/ class will be decided on the performance of the student in the 16 courses / papers including the 14 Core Courses (CC) / papers and two EC / papers.

2.3 The one DSE or one GE, two AECC, one AEC papers will be qualifying in nature and a student has to score at least 45% marks in these papers. Grade will be awarded separately for these courses, however, performance in these elective courses/ papers will not be considered for awarding the final CGPA/ class.

2.4 Ability Enhancement Compulsory Courses (AECC):

University will run two Ability Enhancement Compulsory Courses (AECC) which are qualifying in nature and a student has to qualify in both these courses. The courses are:

| AECC-1 : Environmental Sustainability (3 Credit) |
| Swachchha Bharat Abhiyan Activities (2 Credit) |

Students will do assignments/project work related to institutional social responsibilities including Swachchha Bharat Abhiyan Activities during SEMESTER BREAK.

2.5 University will run a number of Ability Enhancement Courses (AEC) and Skill Enhancement Courses; a student can choose one from these. For example:

**Basket Ability Enhancement Courses (AEC)**

- Computers and IT Skill
- Web Designing
- Financial Risk Management/
- Solid waste Management/
- Mushroom Culture /
- Bio-fertilizer production/
- Environmental Law/
- Tourism & Hospitality Management/
- Lifeskill & skill development /
- Yoga Studies
  etc.
2.6 Discipline Specific Elective (DSE):

In each subject the CC / paper -5 being taught in the second semester will be open to be selected as a DSE paper. In the first phase a student will be allowed to choose a paper from any subject other than his/ her Core Course (CC) from the same faculty in the same university.

2.7 Generic Elective (GE) Course:

University will run a number of Generic Elective Courses (GE); a student can choose one from these. For example:

<table>
<thead>
<tr>
<th>Basket of GE courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Music</td>
</tr>
<tr>
<td>• Dramatics</td>
</tr>
<tr>
<td>• Fine Arts</td>
</tr>
<tr>
<td>• Graphic Design</td>
</tr>
<tr>
<td>• Inclusive Policies</td>
</tr>
<tr>
<td>• Human Rights</td>
</tr>
<tr>
<td>• Any course run by any department</td>
</tr>
</tbody>
</table>
# M.A. /M.Sc. STATISTICS

## SCHEME OF EXAMINATION

### First year: Semester I (July to December)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course</th>
<th>Credits</th>
<th>Max. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSTA CC 01</td>
<td>Real Analysis and Probability</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MSTA CC 02</td>
<td>Linear Algebra and Operations Research</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MSTA CC 03</td>
<td>Statistical Computing</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MSTA CC 04</td>
<td>Practical</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**Part A:** Based on Paper (CC 01 to CC 03) + Viva voce
**Part B:** Group Discussion

Continuous Internal Assessment (CIA)

Total

<table>
<thead>
<tr>
<th>Max. Marks</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

### First year: Semester II (January to May)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course</th>
<th>Credits</th>
<th>Max. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSTA CC 05</td>
<td>General Statistics</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MSTA CC 06</td>
<td>Liner Models and Regression Analysis</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MSTA CC 07</td>
<td>Sample Survey &amp; Design of Experiment</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MSTA CC 08</td>
<td>Distribution Theory &amp; Non- Parametric Tests</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MSTA CC 09</td>
<td>Practical</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**Part A:** Based on Paper (CC 05 & CC 06)
**Part B:** Based on Paper CC 07 & CC 08

Continuous Internal Assessment (CIA)

Total

<table>
<thead>
<tr>
<th>Max. Marks</th>
<th>470</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

\[\text{Signature}\]

\[\text{Date}\]

\[\text{Approving Authority}\]

\[\text{Date}\]
### Second year: Semester III (July to December)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course</th>
<th>Max. Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSTA CC 10</td>
<td>Reliability theory</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>MSTA CC 11</td>
<td>Statistical Inference</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>MSTA CC 12</td>
<td>Multivariate Analysis</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>MSTA CC 13</td>
<td>Stochastic Process</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>MSTA CC 14</td>
<td>Practical</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**Continuous Internal Assessment (CIA)**

**Total**

<table>
<thead>
<tr>
<th>Max. Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td></td>
</tr>
<tr>
<td>470</td>
<td>25</td>
</tr>
</tbody>
</table>

### Second year: Semester IV (January to May)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course</th>
<th>Max. Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSTA EC 01</td>
<td>Demography</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>MSTA EC 02</td>
<td>Operation Research</td>
<td>70</td>
<td>5</td>
</tr>
</tbody>
</table>

**Continuous Internal Assessment (CIA)**

**Total**

<table>
<thead>
<tr>
<th>Max. Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td></td>
</tr>
<tr>
<td>280</td>
<td>10</td>
</tr>
</tbody>
</table>

**Grand total of Semester I to Semester IV**: 1620

**Grand total of Credits for all the Semester**: 80
M.A. /M.Sc. STATISTICS

SCHEME OF EXAMINATION

Passing of Examination and Promotion Rule

The Post Graduate Course in STATISTICS shall be of two academic sessions comprising of FOUR SEMESTERS. Each academic session shall consist of two Semesters – I & III from July to December and Semester - II & IV from January to June.

The total credits including all the four Semesters will be of 80 ; 20 Credits for each Semester. One credit will consist of ten hours of instructions.

Each theory paper irrespective of their nature and credits shall be of 100 marks out of which the performance of a student in each paper will be assessed on the basis of Continuous Internal Assessment (CIA) of 30 marks and the End Semester Examination (ESE) consisting of 70 marks.

The components of CIA shall be

(a) Two Mid Semester Written Tests of one hour duration each 15 Marks
(b) Seminar/Assignments 10 Marks
(c) Regularity, Punctuality & Conduct 5 Marks

In Case of Practical 50 Marks will be for CIA and 50 marks for ESE.

1. There shall be no supplementary examination in any of the Semester Course (I, II, III & IV).

2. A student who has appeared at the CIA and attended the required minimum percentage (75%) of the attendance both in theory and Practical separately shall be permitted to appear in the End Semester Examination (ESE).

3. To be declared passed in ESE in any subject, a students must secure at least 40% marks in each paper separately and a minimum of 45% in total.

A student has to secure minimum 50% marks in CIA of any paper. In case, a student fails to secure minimum 50% marks in CIA of any paper, he/she will be declared fail in that paper. Students shall have to reappear in that paper and in CIA examination also in the same semester of next academic session.

If students fail to secure minimum 50% marks in CIA of any paper his result will be declared as fail in that paper. Students shall have to reappear in that paper in the same semester of next academic session.

A promoted candidate, if he has passed in CIA but fails in theory paper/papers, he/she shall retain his/her CIA award and will reappear in the theory paper only of the semester whenever available. However, if a candidate is declared fail in any End Semester Examination, shall retain nothing and will have to redo the course work of failed semester again and he has to appear again in CIA as-well-as in theory paper.
4. If a candidate passes in at least two paper in his/her First, Second and third End Semester Examination, he/she shall be promoted to next higher semester. But he/she will have to clear their backlog papers in the next end semester examination of that semester whenever it is available. Even if a student is promoted to fourth semester his final result will only be declared when he/she has cleared all their backlog papers.

5. Final result of M.Sc. will be published only after he/she has cleared all the 16 paper securing minimum qualifying marks.

6. Student shall be awarded Grade Point (GP) at the end of each semester examination and Cumulative Grade Point (CGP) at the end of final End Semester Examination in 10 point scoring system.

**Declaration of Result**

The following grading system shall be used by teacher/ Examination department

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Percentage Range</th>
<th>Number of Letter Grade</th>
<th>Description of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90-100</td>
<td>10</td>
<td>Outstanding</td>
</tr>
<tr>
<td>B</td>
<td>80-89</td>
<td>9</td>
<td>Excellent</td>
</tr>
<tr>
<td>C</td>
<td>70-79</td>
<td>8</td>
<td>Very Good</td>
</tr>
<tr>
<td>D</td>
<td>60-69</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>E</td>
<td>50-59</td>
<td>6</td>
<td>Average</td>
</tr>
<tr>
<td>P</td>
<td>45-49</td>
<td>5</td>
<td>Pass</td>
</tr>
<tr>
<td>F</td>
<td>Less than 45</td>
<td>Less than 5</td>
<td>Fail</td>
</tr>
</tbody>
</table>

A student shall be declared to have passed and promoted to the next semester when he/she earns P or above grade in the semester examination covering continuous evaluation, mid term and end term examination.
Semester – I
Unit – I
Compact Set, Bolzano-Weirstrass theorem, Heine-Borel theorem, Uniform convergence, Power series & Radius of convergence

Unit – II
Classes of Sets, field, sigma-field, minimal sigma-field, Borel -field in R^k, Sequence of sets, limsup and liminf of sequence of sets, Measure, Probability measure, properties of a measure, catatheodory extension theorem (statement only), Lebesgue and lebesgue Stieltjes measure on R^k

Unit – III
Random variables, sequence of random variables, almost sure convergence. Convergence in probability (and in measure), Integration of a measurable function with respect to a measure, Monotone convergence theorem. Fatou’s lemma, Dominated convergence theorem.

Unit – IV
Borel-Cantelli Lemma, Independence, Weak law and Strong law of large numbers for iid sequence

Unit – V
Convergence in distribution, characteristic function, uniqueness theorem, levy’s continuity theorem (statement only), CLT for a sequence of independent random variables under Lindberg’s condition, CLT for iid random variables.

Reference:
Apostol, T.M. : Mathematical Analysis, Narosa, Indian Ed.
Billingsley, P : Probability and Measure, John –Wiley NY.
H.L.Royden: Real Analysis, Prentice Hall of India.
Shanti Narayan and Singhania M.D.R: Elements of Real Analysis, S. Chand & Company, New Delhi

\[\text{Amol R} \quad \text{Antik} \quad \text{S.K. Singh}\]
\[12.06.18 \quad 12.06.18 \quad 12.06.18\]
\[(\text{A. Mishra}) \quad (\text{Arun Kumar Bhat}) \quad (\text{S.K. Singh})\]
MSTA CC 02 : Linear Algebra and Operations Research

Unit – I
Linear transformations, algebra of matrices, row and column spaces of a matrix, elementary matrices, rank and inverse of a matrix, partitioned matrices

Unit – II
Solution of matrix equations, characteristics root and vectors, similar matrices, generalised inverse of a matrix.

Unit- III
Definition and scope of operations research, different type of models in operations research, elements of Linear Programming Problem. Formulation of LPP, Solution of LPP through graphical and simplex method, artificial basis technique. Principles of duality in LPP, dual-primal relationship.

Unit – IV

Unit – V
Queuing Models : Specifications and effectiveness measures, steady state solutions of (M/M/I) and (M/M/C) models with associated distributions of queue length and waiting time. Inventory theory: Elementary models with and without shortage.

Reference:
Kanti Swarup, Gupta, P.K and Singh M.M (1985) : Operations Research; Sultan Chand & Sons

12/06/18 (A. Mishra)
12/16/18 (Amr Kumar Dinkar)
12/06/18 (S.K. Swigh)
MSTA CC 03 : STATISTICAL COMPUTING

Unit-I
Programming in C++, Input/Output Statements, constant and variables, data type, variable’s scope, control statements, arrays, function and pointer.

Unit-II
Concept of Object Oriented Programming, class and object, structure, property of Inheritance, Polymorphism, Constructor and Destructor, Overloading and Overriding of functions, static member variable and functions and virtual functions in C++.

Unit-III
Elementary Java programming. Input/Output statements, arrays, function, control statements, Class and object. Properties of Inheritance, Overloading and Overriding of functions, Concept of Packages. Solutions of Statistical Problems based on C++ and JAVA.

Unit IV
MINITAB and SPSS for Graphics, Descriptive Statistics, Representation of Multivariate data, simple hypothesis tests, analysis of variance and linear regression.

Unit-V
Data base management, data warehousing and data mining.

References:
Bala Guruswany E: Programming in ANSI C++, Tata Mc Graw Hill
Dunham, M.H. : Data Mining Introduction and Advanced Topics, Dorling Kinerley (India) Pvt. Ltd.
Guddis Tonny : Starting out with C++ Dream Tech, Press, New Delhi

\[\text{Signature: } A. Mishra \quad 12.06.18\]

\[\text{Signature: } S. K. Singh \quad 12.06.18\]
There will be one sitting of practical examination of three hours duration based on theory paper CC01 to CC03. The distribution of marks will be as follows:

<table>
<thead>
<tr>
<th>Practical note-book and viva-voice</th>
<th>25 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Discussion</td>
<td>25 marks</td>
</tr>
</tbody>
</table>

(A. Mishra) 12/06/18

(S. K. Swich) 12/06/18
Semester – II
Unit -I
Measures of variability, Skewness and Kurtosis for the study of nature of data. Simple linear model, ordinary bent squares, estimation and prediction, properties of regression coefficients, Multiple regression, Multiple and Partial correlations.

Unit -II
Basic concept of Sampling from a finite population, Sampling versus complete enumeration, simple random sampling, sample size determination, Stratified random sampling. Analysis of variance one way and two way classified data, Data analysis using SPSS and R programming.

UNIT-III
Time series and its various components, Test of significance, Large sample test, small sample test based on t and F, Tests based on $X^2$, Non parametric tests.

Unit-IV
Fertility and Mortality, Standardised rate, Life table, Basic concept of Process control Charts for Attributes and variables $\bar{X}$, R, c and p charts

Unit-V
Concept of probability and its basic rules, conditional probability, Baye’s theorem, Probability distributions, Binomial, Poisson, uniformal, normal.

References:
Sukhatme P.V, Sukhatme B.V., Sukhatme S and Ashok, C (1964) : Sampling Theory of Survey with Applications
Unit-I

Gauss-Markov Set-up, Normal equations and Least square estimates. Variance and Covariances of least square estimates, estimation of error variance, least square estimates with restrictions on parameters. Simultaneous estimates of linear parametric functions. Test of hypotheses for one and more than one linear parametric functions. Confidence intervals and regions.

Unit- II

Fitting of different curves, fitting & use of orthogonal polynomials.

Unit- III

Estimability, best point estimates/interval estimates of estimable linear parametric functions and testing of linear hypotheses.

Unit-IV

Residuals and their plots Tests for departure from assumptions such as fitness of the model, normality, homogeneity of variances and detection of outliers. Remedies.

Unit-V

Multicollinearity, Ridge regression, subset selection of explanatory variables, Introduction to logistic regression.

References:

Unit – I
Unequal Probability Sampling: pps wr/wor methods including Lahri scheme and related estimators of finite population mean, Hansen- Hurwitz and Desraj estimators for a general sample size and Murthy’s estimators for a sample of size two, Ratio and regression estimators based on srswor method of sampling

Unit – II
Two stage sampling with equal number of second stage unit. Double sampling, Cluster sampling, Randomized response technique, Warner’s model: related and unrelated questionnaire methods.

Unit – III

Unit – IV
Fixed, mixed and random effect models, Variance component’s estimation. Study of various models. Multiple comparison tests due to Tukey and Scheffe, Simultaneous confidence interval.

Unit – V
Application areas: Response surface experiments first order and orthogonal designs. Fractional replication for symmetric factorials, Split Plot design.

Reference:
Des Raj and Chandak (1998): Sampling theory, Narosa,

[Signatures]
MSTA CC 08 : Distribution Theory and Non-Parametric Tests

Unit – I

Brief review of basic distribution theory, Joint marginal and conditional p.m.fs and p.d.fs. Standard discrete and continuous distributions, Bivariate normal & Bivariate exponential distribution. Function of random variables and their distributions using Jacobian of transformation and other methods.

Unit – II

Compound, truncated and mixture distributions, Markov, Holder, Jensen and Liapounoff inequalities, Sampling distribution, Non-central Chi-square, t and F-distributions and their properties.

Unit – III


Unit-IV

Rank-test. One sample location problem, sign test and signed-rank-test, two sample K-S test, two sample location & scale problems, Wilcoxon Mann-Whitney test, Non-parametric regression and analysis of variance techniques.

Unit – V


References:

UNDP Human Development Report 2011: Sustainability and Equity, A better Future for All
UNDP Publication, USA
UNESCO – Principles of vital statistics system series M-12.

\[ \text{Signature: } \text{Amaldeep}\]
\[ \text{Signature: } \text{A. Mishra}\]
\[ \text{Signature: } \text{S.K. Singh}\]
\[ \text{Date: } 12.06.18\]
\[ \text{Date: } 12.06.18\]
There will be two parts each of three hours duration. The distribution of marks will be as follows:

<table>
<thead>
<tr>
<th>Part A</th>
<th>Based on Paper CC 05 &amp; CC 06</th>
<th>-</th>
<th>25 Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part B</td>
<td>Based on Paper CC 07 &amp; CC 08</td>
<td>-</td>
<td>25 Marks</td>
</tr>
</tbody>
</table>

(A. Mishra)

(S. K. Singh)
Semester – III
Unit-I
Reliability, concept and measures; components and systems; coherent systems; reliability of coherent systems; cuts and paths; modular decomposition; bounds on system reliability; structural and reliability importance of components. Life distribution; reliability function; hazard rate; common life distributions-exponential, Weibull, gamma etc. Estimation of parameters and tests in these models.

Unit-II
Notions of ageing; IFR, IFRA, NBU, DMRL and NBUE Classes and their duals; closures of these classes under formation of coherent systems, convolutions and mixtures. Univariate shock models and life distribution arising out of them; bivariate shock models; common bivariate exponential distributions and their properties.

Unit-III
Reliability estimation based on failure times in variously complete and censored life tests and in tests with replacements of failed items; stress strength reliability and its estimation.

Unit-IV
Maintenance and replacement policies; availability of repairable systems; modelling of a repairable system by a non homogenous poisson process.

Unit-V
Reliability growth models; probability plotting technique; Hollander-Proshan and Deshpande tests for exponentiality tests of HPP vs NHPP with repairable systems. Basic ideas of accelerated life testing.

References:
Reliability and life testing by S.K. Sinha, John Wiley Eastern Limited
MSTA CC 11 : Statistical Inference

Credit : 5

Unit -I
Sufficiency, Neyman Factorization criterion, Exponential families and Pitman families, Invariance Property of Sufficiency, Minimum Variance Unbiased estimators, completeness, Lehmann-Scheffe Theorem.

Unit -II
BAN and CAN estimators. Pitman’s method, Method of Scoring, Multinomial distribution with cell probabilities depending on a parameter, MLE in censored and truncated distributions.

UNIT-III
Neyman- Pearson Lemma and its applications. MP and UMP tests. UMP tests for simple null hypothesis against one sided alternatives Likelihood Ratio-test, Asymptotic distribution of LR criterion.

Unit-IV
MP and UMP tests in Pitman family. Distribution with MLR property. UMP tests for one sided null against one sided alternative in one parameter exponential family.

Unit-V
Wald’s SPRT, Determination of Constants, Approximate OC and ASN functions and their approximate expressions, OC and ASN function of Bernoulli. Normal and Exponential distributions. Variance stabilizing transformations. Asymptotic power of large sample tests.

References:
Kele, B.K.: A First course on Parametric Inference, Second Edition Narosa
Unit – I
Multivariate normal distribution, its properties and characterizations, Random sampling from multivariate normal distribution. Maximum likelihood estimators of parameters. Distribution of sample mean vector.

Unit – II
Wishart distribution- its derivation and properties. Distributions of sample generalized variance. Distribution of quadratic form

Unit – III
Null and Non-Null distribution of simple correlation coefficient. Null distribution of partial and multiple correlation coefficient. Distribution of sample regression coefficients.

Unit – IV
Hotelling’s $T^2$ statistics- its distribution and properties, Applications in test on mean vector for one and more multivariate normal populations, Mahalanobis $D^2$ classification and discrimination procedures for discrimination between two multivariate normal populations, Fisher’s Discriminant function tests associated with discriminant functions.

Unit – V
Canonial variates and canonical correlation. Principal Component Analysis. Elements of factor analysis and cluster analysis.

References :
Kshirsager, A.M. (1972): Multivariate Analysis, Marcel Dekker
Unit – I
Introduction to stochastic process: Classification of stochastic process according to state space and time domain, Continuous state Markov Chain, Chapman- Kolmogorov equations Calculation of n-step transition probability and its limit.

Unit – II
Stationary distribution, classification of states, Markov – chain Random walk and Gambler’s ruin problem, applications to social, biological and physical science.

Unit- III
Discrete state space, continuous time, M.C.Kolmogrov –Feller differential equations, Poisson process. Birth and Death process.

Unit- IV
Applications to queues and storage problems, Wiener process as a limit of random walk, first passage time and other problems.

Unit-V

References:
B.R. Bhatt : Stochastic Models, New Age Publishers
Seldon M Ross : Stochastic Process, Wiley Student Publication
Singh, BM : Measure, Probability and Stochastic Processes, South Asian Publisher, New Delhi.

\[ \text{Amol} \quad 12.06.18 \quad (A. Mishra) \]

\[ \text{Andish} \quad 12.06.18 \quad (C. S. K. Singh) \]
MSTA CC 14: Practical and group discussion

There will be one sitting of practical examination of three hours duration based on theory paper CC 10 to CC 13. The distribution of marks will be as follows:

- Practical: Based on Paper CC 10 to CC 13
  - 20 marks
- Field work
  - 30 marks

Signed:
- [Signature]
  - 12.06.18
  - (A. Mishra)
- [Signature]
  - 12.06.18
  - (A. Likh)
- [Signature]
  - 12.06.18
  - (S. K. Singh)
Semester – IV
Unit I

Unit II
Measures of fertility, Stochastic models for reproduction, distribution of time to first birth, interlive birth interval and of number of births (for both homogeneous and non-homogeneous groups of women) estimation of parameters; estimation of parity progression ratios from open birth interval data.

Unit III
Measure of Mortality; construction of abridged life tables, Distribution of life table functions and their estimation.

Unit IV

Unit V

Reference:

Benjamin B. (1969) : Demographic Analysis, Geogre Allen and Unwin
Keyfit, N (1970) : Applied Mathematical Demography; Springer Verlag
Nathan K. (1968) : Introduction to the Mathematics of Population Reading, Mann : Addison-Wesley
Pathak, K.B. & Ram, F : Techniques of Demographic Analysis; Himalaya Publishing House
Ram Kumar : Technical Demography
Unit – I
Definition and scope of operations research: Phases in Operations Research: models and their solution; decision-making under uncertainty and risk, use of different criteria: sensitivity analysis

Unit – II

Unit – III
Simulation, Analytical structure of inventory problems; EOQ formula of Harris, its sensitivity analysis and extension allowing quantity discounts and shortages. Multi –item inventory subject to constraints. Models with random demand, the static risk model.

Unit – IV

Unit – V
Sequencing and Scheduling problem. 2 machine n-jobs and 3-machine n jobs with identical machine sequence for all jobs; 2 jobs n machine problem. Branch and bound method for solving travelling salesman problems

References:

Kanti Swarup, Gupta, P.K and Singh M.M (1985) : Operations Research; Sultan Chand & Sons