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ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

BENGALURU
CITY UNIVERSITY

Office of the Registrar, Central College Campus, Dr. B.R. Ambedkar Veedhi, Bengaluru – 560 001.
PhNo.080-22131385, E-mail: registrarbcu@gmail.com

No.BCU/BoS/NEP/Statistics /313 /2022-23 Date: 23.11.2022.

NOTIFICATION

Sub: B.Sc. III & IV Semesters Statistics Syllabus of Bengaluru City University-reg.

Ref: 1. University Notification No. BCU/New Syllabus as per NEP/235/ 2022-23 dated: 12.10.2021.
2. Recommendations of the BoS in Statistics (UG)
3. Approval of the Vice-Chancellor dated: 22.11.2022.

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In pursuance to the recommendations of the BoS in Statistics (UG) and the approval of the Vice-Chancellor cited at reference (2 & 3) above, the B.Sc. III & IV Semester Statistics Syllabus of Bengaluru City University effective from the academic year 2022-23, is hereby notified for information of the concerned.

The copy of the Syllabus is notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

To:
The Registrar (Evaluation), Bengaluru City University, Bengaluru.

Copy to;

1. The Dean, Faculty of Science, BCU.
2. The Chairman & Members of BoS in Science (UG), BCU.
3. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
4. Office copy / Guard file / University Website: www.bcu.ac.in

ಬೆಂಗಳೂರು ನಗರ ವಿಶ್ವವಿದ್ಯಾಲಯ

BENGALURU CITY UNIVERSITY

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BE BOUNDLESS

BENGALURU CITY UNIVERSITY

Board of Studies in Statistics

Central College Campus, Bengaluru – 560 001

Syllabus for III & IV Semester Statistics –Discipline Core Under-Graduate (UG) Program

Framed according to the National Education Policy (NEP 2020)

BENGALURU CITY UNIVERSITY

Regulations and Syllabus for STATISTICS

in

B.Sc. and B.Sc. (Honours) Course (CBCS 2021)

Preamble

Several reforms in our education system has been proposed and developed by Ministry of HRD as National Education Policy (NEP)2020 which includes broad based multidisciplinary undergraduate education with necessary knowledge, skills and competencies. It also proposes to bring equity, efficiency and academic excellence at different levels of education. NEP also recommended multidisciplinary undergraduate programmes with multiple exit and multiple entry options with the provision of Certificate/Diploma/Degrees at each of the exits.

Probability and Statistics is the language of uncertainties, riddled modern information age. Statistics facilitates the decision making process by quantifying the element of chance or uncertainties. Its descriptive and inferential procedures not only formulate the basis of the growth of almost all disciplines of the contemporary world, and also provide an array of employment avenues in all fields. This is a rigorous program in Probability Theory, Statistical Inference, Multivariate Analysis, Linear Models and Regression Analysis and Sample surveys and Design of Experiments designed to give a sound foundation in fundamentals and training in practical Statistics leading to statistical data analysis.

The eight semester 176 credit program has a variety of elective courses to choose from including enough courses on statistical software. A person successfully completing the program will have enough knowledge and expertise to statistically analyze small and large univariate and multivariate data sets, pursue advanced courses in Statistics or a Ph.D. in Statistics, work in software/data analytics industry as domain expert, independently consult for statistical data analysis.

In this direction, the Board Studies in Statistics (PG&UG) approved the syllabus along with structure and schemes for BSc, BSc (Honours) and MSc programmes. The Board of Studies consists of experts as below:

BENGALURU CENTRAL UNIVERSITY
BOARD OF STUDIES IN STATISTICS

Date:02-11-2022

Proceedings of the meeting of the Board of Studies in Statistics (UG) held at 11.00 am on 02-11-2022 in the Department of Statistics , Jnana Bharathi Campus, Bangalore university, Bangalore.

The meeting started with welcome of the members by the Chairperson of the board of studies. The following decisions were taken.

1. The members discussed and approved the syllabus for III and IV semesters of UG optional Statistics as per NEP guidelines.
2. The panel of examiners for B Sc examinations for the year 2022-23 is approved.

Members Present:

1. Dr. Prakash, R. Associate Professor,
   Vijaya College, Bengaluru
2. Narayana Gowda, N.,
   Reva University, Bengaluru
3. Dr. Raveendra Naika, T., Associate Professor,
   Maharani Cluster University, Bengaluru
4. Prof. Parameshwar V Pandit (Chairperson)
   Department of Statistics, Bangalore University, Bengaluru

R.Prakash 2/11/2022

2/11/22

2/11/2022

Dr. Parameshwar. V. Pandit
Professor, Department of Statistics
Bangalore University
BENGALURU-560 056

Eligibility

Only those candidates who have passed XII/Pre-University course or an equivalent course with Statistics/ Mathematics/ Basic Mathematics/Applied Mathematics as one of the optional subjects are eligible to take Statistics as one of the optional subjects in BSc course.

Scheme of Instruction/ Examination

1. The subject Statistics in this course, has to be taught by MSc/MA degree holders in Statistics / Applied Statistics.
2. The theory question paper for each paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
3. The practicals are to be conducted in batches as per the University norms for the faculty of science (normally 10 students per batch per teacher).
4. Two teachers are to be assigned for each batch with not more than 20 students for giving instructions, supervision, and correction of records.
6. It is expected that each student collects and uses real life data for the practical classes.
7. Students are required to use Statistical software, run the programmes, and enclose computer outputs to the practical records in the case of computer based practicals.
8. Maximum marks for each record in the examination is 5.
9. Study tour for the students is strongly recommended to gain practical knowledge of applications of Statistics in Industries/Agriculture/Medical field.

Bachelor of Science (Basic/Hons.)

With Statistics as one of the majors with practicals with other subject as another major in 2rd year

(III and IV semesters)

Bachelor of Science (Basic/Hons.)

(as Major as well as Minor)

(III and IV semesters)

Model Program Structures for the Under-Graduate Programs in Universities and Colleges in Karnataka

Bachelor of Science (Basic/Hons.) /Bachelor of Arts (Basic/Hons.) With Statistics as one of the majors with practicals with other subject as another major in 3rd year

Sem.	Discipline Core (DSC)(Credits) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits)(L+T+P)		Skill Enhancement Courses (SEC)		Total Credits
					Skill based (Credits) (L+T+P)	Value based (Credits) (L+T+P)	
I	**Descriptive Statistics** (4+2) Discipline B1(4+2)	OE-1 (3)	L1-1 (3), L2-1 (3)(3+1+0 each)		SEC-1: Digital Fluency (2) (1+0+2)		**25**
II	**Probability and Distributions** (4+2)Discipline B2(4+2)	OE-2 (3)	L1-2(3), L2-2 (3) (3+1+0 each)	Environmental Studies (2)		Health & Wellness/ Social & Emotional Learning (2) (1+0+2)	**25**
Exit option with Certificate (48 credits)							
III	**Calculus and Probability Distributions** (4+2) Discipline B3(4+2)	OE-3 (3)	L1-3 (3), L2-3(3) (3+1+0 each)		SEC-2: Artificial Intelligence (2)(1+0+2)		**23**
IV	**Statistical Inference-I** (4+2) Discipline B4(4+2)	OE-4 (3)	L1-4 (3), L2-4(3) (3+1+0 each)	Constitution of India (2)		Sports/NCC/NSS etc. (2) (1+0+2)	**25**
Exit option with Diploma (96 credits)							
V	**Matrix Algebra and Regression Analysis** (3+2) **Analysis of variance and design of experiments** (3+2) Discipline B5(3+2)	DS-B Elective 1 (3)			SEC-3: Cyber Security (2) (1+0+2)	Ethics & Self Awareness (2) (1+0+2)?	**20**
VI	**Statistical Inference-II** (3+2) Discipline B6(3+2) Discipline B7(3+2)	DS-A Elective 1 (3)			SEC-4: Professional/ Societal Communication (2)		**20**
Exit option with Bachelor of Arts, B.A. / Bachelor of Science, B. Sc. Basic Degree (136 credits)							

Choose any one Discipline as Major

VII	**Sample Surveys and Statistics for National Development** (3+2) **Real Analysis** (3+2) **Probability Theory** (4)	DS-A/B Elective 2(3) Res. Methodology(3)					**20**
VIII	**Linear Algebra** (4) **Linear models and Design of Experiments** (4)	DS-A/B Elective 3(3) DS-A/B Elective 4(3) Research Project (6)*					**20**
Award of Bachelor of Arts Honours, B.A. (Hons.)/ Bachelor of Science Honours, B.Sc. (Hons) degree in a discipline etc. (176 credits)							
IX	**Multivariate Analysis** (3+2) **Decision Theory and Bayesian Inference** (3+2) **Distribution Theory** (4)	DS-A/B Elective 2(3) Res. Methodology(3)					**20**
X	**Stochastic Processes** (4) **Time Series Analysis** (4)	DS-A/B Elective 3(3) DS-A/B Elective 4(3) Research Project (6)*					**20**
Award of Master of Science Degree in Statistics							

Summary of Discipline Specific Courses (DSC)			
Semester	**Course Code**	**Title of the Paper**	**Credits**
I	DSC A1	Descriptive Statistics	4
		Practicals based on DSC A1	2
II	DSC A2	Probability and Distributions	4
		Practicals based on DSC A2	2
III	DSC A3	Calculus and Probability Distributions	4
		Practicals based on DSC A3	2
IV	DSC A4	Statistical Inference-I	4
		Practicals based on DSC A4	2
V	DSC A5	Matrix Algebra and Regression Analysis	3
		Practicals based on DSC A5	2
	DSC A6	Analysis of variance and design of experiments	3
		Practicals based on DSC A6	2
VI	DSC A7	Statistical Inference-II	3
		Practicals based on DSC A7	2
	DSC A8	Sample Surveys and Statistics for National Development	3
		Practicals based on DSC A8	2
VII	DSC A9	Real Analysis	3
		Practicals based on DSC A9	2
	DSC A10	Probability Theory	4
	DSC A11	Theory of Estimation	3
		Practicals based on DSC A11	2
VIII	DSC A12	Linear Algebra	4
	DSC A13	Testing of hypotheses	4
	DSC A14	Linear models and Design of Experiments	3

Semester	Course Code	Title of the Paper	Credits
IX	DSC A15	Multivariate Analysis	3
		Practicals based on DSC A15	2
IX	DSC A16	Decision Theory and Bayesian Inference	4
	DSC A17	Distribution Theory	3
		Practicals based on DSC A17	2
X	DSC A18	Stochastic Processes(4)	4
	DSC A19	Time Series Analysis (3)	4
	DSC A20	Machine Learning (4)	3

List of Open Elective (OE) for III and IV semesters

1) Population Studies
2) Survival Models
3) Operations Research
4) Quantitative Analysis Techniques

Assessment for Discipline Specific Core(DSC) Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	**40**	**60**
Practical	**25**	**25(20+5(Practical record))**
Projects	**40**	**60**
Experiential Learning (Internships, etc.)	**40**	**60**

Syllabus for Statistics (as Major as well as Minor)

(III and IV semesters)

B.Sc.

III Semester

Course Title: **Calculus and Probability Distributions**	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 ½ hours
Model Syllabus Authors: State level NEP-model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	52

Course Objectives

To enable the students to

1. Know the concept of continuity, differentiability, integration of one and more variables.
2. Define and describe properties of Joint, Marginal and conditional distributions of variables and some key concepts of probability theory.
3. Understand different discrete, continuous and sampling distributions, properties and their applications.
4. Generate random variables from various distributions using R-code.

Course outcomes

After completion of this course the students will be able to

1. Judge continuity of a function, find integrations and solve problems of differentiability.
2. Solve problems of various analytical environments using different distributions and their properties.
3. Find sampling distributions of functions of random variables and explore their applications.

Theory Paper -3
Calculus and Probability Distributions

Content of Theory Paper 3	56 Hrs
UNIT 1: Calculus of one and more variables	**12 Hrs**
Applications of basic calculus in Statistics - Review of calculus of one variable, continuity, differentiability, Taylor 's series expansion. Functions of several variables, partial derivatives and their application, Jacobians. Integration-introduction, integration by parts, multiple integral and it's evaluation by repeated integration(over rectangles only). Sequences and series of real numbers and their convergence, tests for the convergence of series (only results and applications).	
UNIT 2: Distribution of Random Variables (Two-dimensional)	**16 Hrs**
Two dimensional random variables: Joint distribution, Marginal distribution and Conditional distributions of random variables, conditional expectation, covariance, correlation and moments. Distribution of functions of random variables using m.g.f. and distribution function. Transformation of variable technique (one and two variables). Chebyshev's inequality- proof and its use in approximating probabilities; Statements of Weak Law of Large Numbers; Convergence in law and Central Limit theorems – De-Moivre. (Some simple examples)	
UNIT 3: Probability Distributions-II	**12 Hrs**
Discrete distributions: Negative Binomial, Hypergeometric, Multinomial-definition through probability mass function, mean, variance, moments, m.g.f., other properties and applications. **Continuous distributions:** Cauchy, Weibull– definition through probability density function, mean, variance, moments, m.g.f., other properties and applications. Bivariate normal distribution- definition through probability density function, marginal and conditional distribution.	
UNIT 4: Sampling Distributions and Simulation	**16 Hrs**
Definitions of random sample, parameter and statistic, sampling distribution of sample mean, standard error of sample mean, sampling distribution of sample variance, standard error of sample variance. **Exact sampling distributions**: Chi square distribution- mean, variance, moments, mode, additive property. Student's and Fisher's t-distribution- mean, variance, moments and limiting form of t distribution. Snedecor's F-distribution: mean, variance and mode. Distribution of 1/F. **Introduction to simulation**. Generation of random observations from Uniform, Exponential, Normal, Binomial, Poisson distributions.	

References

1. Andre I Khuri (2003). Advanced Calculus with Applications in Statistics, Second Edition, John Wiley & Sons.
2. Ghorpade, S. R. and Limaye, B. V. (2006). A Course in Calculus and Real Analysis, Springer
3. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
4. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
5. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference,10th Edition, Pearson Education, New Delhi.
6. Jay Kerns, G. (2010). Introduction to Probability and Statistics using R. 1st Edition, Springer.
7. Rohatgi, V.K. and A.K. Md. Ehsanes Saleh. (2002). An Introduction to Probability Theory and Mathematical Statistics, New York, John Wiley.
8. Ross, S. M. (2014). Introduction to Probability Models. 11th Edition, Elsevier science.
9. Ross, S. M. (2012). Simulation. Academic Press.
10. Shanthi Narayana (2000), Integral Calculus, S. Chand & Co. Ltd.
11. Shanti Narayana (2000). Differential Calculus, S. Chand & Co. Ltd.
12. Verzani, J. (2002). Simple R - Using R for Introductory Statistics.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	40

Contents of Practical -III

Note: The first practical assignment is on R-programming. Practical assignments 2 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

1. Demonstration of R functions for calculus, distribution of random variables, probability distributions, sampling distribution simulation.
2. Numerical differentiation and integration.
3. Bivariate Probability Distributions - Marginal and Conditional distributions,
4. Bivariate Probability Distributions - Conditional Mean, Conditional Variance, Correlation.
5. Applications of Chebyshev's inequality (For standard distributions such as Normal, Exponential, Gamma).
6. Applications of discrete probability distributions - Negative – Binomial, Hyper geometric distributions.
7. Fitting of Negative – Binomial distributions.
8. Applications of continuous probability distributions - Cauchy, Weibull distributions.
9. Generating random sample from discrete distributions.
10. Generating random sample from continuous distributions.

Formative Assessment: Total 25 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	05
Total	25

B.Sc.
IV Semester

Course Title: **Statistical Inference-I**	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2 ½ hours
Model Syllabus Authors: State level NEP-model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Number of Theory Credits	**Number of lecture hours/semester**	**Number of practical Credits**	**Number of practical hours/semester**
4	**56**	**2**	**52**

Course Objectives

To enable the students to understand the concepts of

1. Families of distribution .
2. Estimation, criteria for estimators, methods of estimation, confidence interval.
3. Testing of Hypotheses and its theoretical aspects, large and small sample tests.

Course Outcomes

After completion of the course, the students will be able to

1. Carryout statistical analysis by identifying families of distributions and the use of order statistics.
2. To find estimators using different methods of estimation and compare estimators.
3. To carryout statistical inference using different tests of hypotheses under different scenarios.

Theory Paper- 4

STATISTICAL INFERENCE – I

Content of Theory Paper 4	56 Hrs
UNIT- 1: Point Estimation-I	**14 Hrs**
Families of distributions- location and scale families. Single parameter exponential family. Concepts of estimator and estimate. Criteria for estimators: Unbiasedness, Consistency. Invariance property of consistent estimators. Efficiency and relative efficiency. Mean squared error as a criterion for comparing estimators. Sufficient statistics. Statement of Neyman-Factorization theorem.	
UNIT-2: Point Estimation-II	**12 Hrs**
Fisher information function. Statement of Cramer–Rao inequality and its applications. Minimum Variance Unbiased Estimator and Minimum Variance Bound Estimator. Maximum likelihood and method of moment estimation; Properties of MLE and moment estimators and examples.	
UNIT- 3: Testing of Hypotheses	**22Hrs**
Statistical hypotheses - null and alternative, Simple and composite hypotheses. Type-I and Type-II errors, test functions. Randomized and non-randomized tests. Size, level of significance, Power function, power of tests. Critical region, p- value and its interpretation. Most Powerful (MP) and UMP test. Statement of Neyman-Pearson Lemma and its applications. Likelihood ratio tests. **Large and small samples tests of significance**. Tests for single mean, equality of two means, single variance and equality of two variances for normal populations. Tests for proportions.	
UNIT- 4: Interval Estimation	**08 Hrs**
Confidence interval, confidence coefficient, shortest confidence interval. Methods of constructing confidence intervals using pivotal quantities. Construction of confidence intervals for mean, difference of two means, variance and ratio of variances, proportions, difference of two proportions and correlation coefficient.	

References

1. Chihara, L. and Hesterberg, T. (2011) Mathematical Statistics with Resampling and R. Wiley.
2. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
3. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
4. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, 10th Edition, Pearson Education, New Delhi.
5. Johnson, R.A. and Bhattacharyya, G.K. (2006), Statistics: Principles and methods. 5th Edition, John Wiley & Sons, New York.
6. Kale, B.K. (1999). A First Course on Parametric Inference, New Delhi, Narosa Publishing House.
7. Kendall, M.G., et. al., (1996). An Introduction to the Theory of Statistics, Universal Book Stall.
8. Rohatgi, V.K. and A.K. Md. Ehsanes Saleh. (2002). An Introduction to Probability Theory and Mathematical Statistics, New York, John Wiley.
9. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Formative Assessment: Total 40 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	40

Contents of Practical -IV

Note: The first practical assignment is on R-programming and R packages. Practical assignments 2 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

1. Demonstration of R-functions for estimation and testing of hypotheses.
2. Point estimation of parameters and obtaining estimate of standard errors and mean square error.
3. Computing maximum likelihood and moment estimates.
4. Interval estimation: Construction of confidence interval (large and small samples)
5. Evaluation of Probabilities of Type – I and Type – II errors and power of tests.
6. Tests for mean, equality of means when variance is (i) known, (ii) unknown under normality (small and large samples)
7. Tests for single proportion and equality of two proportions.
8. Tests for variance and equality of two variances under normality.
9. MP tests for parameters of binomial, Poisson distributions.
10. MP tests for parameters of normal distribution.

Formative Assessment: Total 25 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	05
Total	25

Assessment for Discipline Specific Core (DSC) Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40	60
Practical	25	25(20+5(Practical record))
Projects	40	60
Experiential Learning (Internships, etc.)	40	60

List of Open Electives (OE)

SEMESTER-III

1. **Population Studies**
2. **Survival Models**

SEMESTER-IV

1. **Basics of Operations Research**
2. **Quantitative Analysis Techniques**

1. Population Studies

Course Objectives

1. To enable the students to identify appropriate sources of data, perform basic demographic analysis using various techniques and ensure their comparability across populations.
2. To acquire knowledge about the construction of life table and its applications in demographic analysis.

Course Outcomes (CO)

Upon successful completion of this course the student will be able to

CO1. Study the concepts of Vital Statistics, sources of data, different measures of Fertility, Mortality and migration.

CO2. Understand the Growth rates- GRR and NRR and their interpretations.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Contents

UNIT-1: Introduction and Sources of Population Data **14 hours**

History, definition, nature and scope of population Studies. Sources of population data – salient features of Census, Civil Registration System, National Sample Surveys, Demographic Surveys, relative merits and demerits of these sources. Coverage and content errors. Use of balancing equations, Chandrasekar-Deming formula to check completeness of vital registration data, use of Whipple's, Myer's and UN indices.

UNIT-2 : Fertility, Mortality **18 hours**

Basic concepts and terms used in the study of fertility. Measures of fertility- Crude Birth Rate (CBR), General Fertility Rate (GFR), Age Specific Fertility Rate (ASFR), Total Fertility Rate (TFR), Birth order statistics, Child Women ratio. Measures of reproduction- Gross Reproduction Rate (GRR)and Net Reproduction rate(NRR). Measurement of population growth rate- simple growth rate and compound growth rate.

Basic concepts and terms used in the study of mortality. Measures of mortality- Crude Death Rate (CDR), Age Specific Death Rate (ASDR), Direct and Indirect Standardized Death rates, Infant Mortality Rate (IMR), Neo-natal mortality rate, Post-natal mortality rate; Maternal Mortality Rate (MMR).

UNIT-3: Life tables and Population change **10 hours**

Life tables: Components of a life table, force of mortality and expectation of life table, types of life tables. Construction of life tables. Uses of life tables.

Basic concepts and definition of population change, migration. Types of migration- internal and international, factors affecting migration.

References

1. Barclay, G, W(1968). Techniques of Population Analysis, John Wiley and Sons, Incs. New York/London.
2. Keyfitz, H (1968). Introduction to the Mathematics of Population. Addison-Wesley Publishing Co.
3. Pathak, K.B and Ram, F (1991).Techniques of Demographic Analysis, Himalaya Publishing House.
4. Ramakumar. R (1986). Technical Demography, Wiley Eastern Ltd.
5. Srinivasan. K (1998). Basic Demographic Techniques and Applications, Sage Publication, New Delhi.
6. Wunsch G.J. & M.G. Tarmota(1978). Introduction to Demographic Analysis, Plenum Press, N.Y.

2. Survival Models

Course Objectives

1. Enable the students to construct and interpret life tables.
2. To understand the concepts of Survival analysis.
3. To study the design of clinical trials and their analysis.

Course Outcomes:

By the end of this course, the student should be able to:

CO1.Explain Life Tables, types of life tables, its functions, construction. CO2.

Describe multiple decrement life tables and their construction.

CO3. Know survival models, concepts of survival analysis, notion of ageing.

CO4. Explain key concepts in the design of clinical trials, phases, types, clinical trial protocol, analysis.

Content

Unit-1: Life Tables **14 hours**

Basic definition and notations, Types of life tables, inter – relationships between life table functions, Properties of life table functions. Construction of life tables using Reed – merrel and Greville's Method. Competing causes of failure/death, Multiple decrement life tables and their construction (with examples).

Unit-2: Survival Concepts **14 hours**

Life distributions, survival functions, failure rate, Integrated hazard function, residual life time, mean residual life time. Notion of aging: IFR, IFRA, DMRL, NBU, NBUE classes of life distributions and their dual classes. Common Life Distributions: binomial, Poisson, exponential, Weibull, gamma, Pareto and log-normal distributions.

Unit-3: Clinical Trials **14 hours**

Basics of Clinical Trials: Who can be in clinical trials? need clinical trials, Brief History of Clinical Trials, Common Terms in clinical Trials: Clinical Research, Healthy Volunteer, Inclusion/Exclusion Criteria, Informed Consent, Patient Volunteer, Phases of Clinical Trials, Placebo, Protocol, Principal Investigator, Randomization, Types of Clinical Trials. - Diagnostic trials, Natural history studies, Prevention trials, Quality of life trials, Screening trials, Treatment trials, therapeutic trials and prophylactic trials. Observational studies – Cross sectional studies, prospective studies, retrospective studies, randomized control studies. Clinical Trial Protocol and its components. . Odds ratio, Relative risk, Sensitivity, specificity, false negative and false positive rates. Receiver operating characteristic(ROC) curve.

References

1. Deshpande, J V and Purohit, Sudha (2005). Life Time Data: Statistical Models and Methods. World Scientific.
2. Friedman, Furberg, and DeMets. (2010). Fundamentals of Clinical Trials (4th Edition). Springer, Free text available online at http://dx.doi.org/10.1007/978-1-4419-1586-3
3. Lawrence MF, Curt DF, David LD (2010), Fundamentals of clinical trials.
4. R. Ramkumar (1986), Technical Demography, Wiley Eastern, New Delhi.
5. Shryock, Henry S, Jacob S, Siegel and Associates (1964). Methods and materials of demography (condensed edition), Academic press, London.

3. Basics of Operations Research

Course Objectives

1. Students get knowledge about the scope and application of Operations Research(OR) in business and industry.
2. Exposes the students to various OR tools and models.
3. To get knowledge about various decision making through OR models.

Course Outcomes

Students will be able to

CO1- Generate mathematical models of business environment.

CO2-Analyze the business situations.

CO3-Use different solution procedures through OR models.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Contents

Unit-1: Introduction to Operations Research(OR) **14 hours**

Origin and growth of OR, importance of OR in managerial decision making, scope and applications of OR, models and modelling in OR. Linear programming problems(LPP): Formulation of the problem, feasible & infeasible, basic feasible solution, optimal, unbounded and multiple optimal solutions of LPP, solution by graphical method. Slack, Surplus and Artificial variables.

Unit-2: Allocation Problems **14 hours**

Transportation problems: Formulation, methods of finding initial solution (North West Corner Rule, Least Cost Method and Vogel's Approximation Method), unbalanced transportation problems, maximization transportation problem.

Assignment problems: Formulation, methods of solution, Hungarian method, multiple optimal solutions, unbalanced problems, maximization problems.

Unit-3: Decision theory **14 hours**

Game theory: Basic concepts. Two – Person Zero Sum Game. Pure and Mixed Strategies. Maximin – Minimax principle, Games with and without saddle points. Principle of dominance.

Concepts of decision making, decision making environments, Decision making under uncertainty - Decision making under risk, decision tree analysis. Case discussion.

References

1. Hillier, F S, et al. Introduction to Operations Research (9/e). Tata McGraw Hill, 2011.
2. Ravindran, A and Don T Phillips. Operations Research: Principles and Practice. John Wiley & Sons, 1987.
3. Sharma, J K. Operations Research: Theory and Applications (5/e). New Delhi: Laxmi Publications, 2013.
4. Taha, Hamdy A. Operations Research: An Introduction (9/e). Prentice Hall, 2010.
5. Vohra, N D. Quantitative Techniques for Management. Tata McGraw Hill Education, 2015.
6. Kanti Swarup, Gupta, P.K. and Man Mohan: Operations Research, Sultan Chand & Sons, New Delhi.
7. Kapoor, V.K: Operations Research, Sultan Chand & Sons, New Delhi.
8. Kapoor, V.K.: Operations Research Problems & Solutions, Sultan Chand & Sons, New Delhi.

4. Quantitative Analysis Techniques

Course Objectives

To enable the students to acquire the knowledge about

1. The concepts of correlation and regression analysis.
2. The concepts of linear programming problem and its applications.
3. The students will learn the tools of data mining.

Course Outcomes

Students will be able to

CO1. Carryout correlation and regression analysis.

CO2. Formulate and solve linear programming problems.

CO3. Use data mining tools.

Pedagogy

The course is taught using traditional chalk and talk method using problem solving through examples and exercises. Students are encouraged to use resources available on open sources.

UNIT- 1: Correlation and regression analysis **14 hours**

Correlation- Definition, Types - Simple, multiple, partial. Causation - Spurious, positive, negative, perfect and no correlation, explanation with examples. Importance of correlation analysis. Measurement of correlation- scatter diagram, Karl Pearson's coefficient of correlation, Properties of coefficient of correlation, interpretation. Spearman's coefficient of rank correlation –with and without ties, interpretation. Coefficient of determination and its interpretation.

Regression- Definition, regression lines/equations of X on Y and Y on X. Properties of regression coefficients and regression lines/equations. Principle of least squares and fitting of linear, quadratic and exponential curves. Uses of regression analysis. Comparison between correlation and regression.

UNIT-2: Linear programming problem(LPP) **18 hours**

Definition and scope of Operations Research (OR). Modelling and solution. Linear Programming Problem (L.P.P): Definition, Standard forms. Formulation of LPP. Basic Solutions, degenerate and non-degenerate solutions. Graphical method of solving LPP. Criteria for unbounded, Multiple and infeasible solutions.

Transportation problem: Mathematical formulation. Existence of feasible solution. Finding initial basic feasible solution: North West Corner Rule, matrix minima method and Vogel's method. Unbalanced transportation problem.

Assignment Problem: Mathematical Formulation and Hungarian algorithm. Unbalanced assignment problem.

UNIT-3: Data Mining **10 hours**

Motivations and importance of Knowledge Discovery in Databases (KDD) process - search, induction, querying, approximation and compression. Kinds of data considered for data mining, basic data mining tasks, data mining issues, Data Mining models

- predictive and descriptive, interconnections between Statistics and Data Mining. Artificial Intelligence and Machine Learning. Applications of data mining.

References

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I, 8th Ed., The World Press, Kolkata.
2. Ross, S.M. (2014). Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.
3. Kanthi Swaroop, Manmohan and P. K. Gupta (2013). Operation Research, Sultan Chand New Delhi.
4. Mustafi, C. K. (2006). Operations Research Methods and Practice, 3/e. New Age Publication.
5. Narag. A. S. (1970). Linear Programming and Decision Making. Sultan Chand and Co.
6. Sharma, J K.(2013). Operations Research: Theory and Applications (5/e). New Delhi: Laxmi Publications.
7. Jiawei Han, Micheline Kamber (2002). Data mining concepts and Techniques, Morgan Kaufman Publishers, USA.
8. Trevor Hastie, Robert Tibshirani and Jerome Friedman (2001). The elements of Statistical learning: Data Mining, Inference and Prediction, Springer, New York.
9. Rajan Chattamvelli (2009). Data mining methods, Narosa Publishing House.