ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Programme: B.Sc. Honours in Statistics (Major)

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Essentials and Applications of Mathematical, Physical and Chemical Sciences	3+2	4
		2	Advances in Mathematical, Physical and Chemical Sciences	3+2	4
	II	3	Descriptive Statistics	3	3
			Descriptive Statistics Practical Course	2	1
		4	Random Variables & Mathematical Expectations	3	3
			Random Variables & Mathematical Expectations Practical Course	2	1
II	III	5	Theoretical Discrete Distributions	3	3
			Theoretical Discrete Distributions Practical Course	2	1
		6	Theoretical Continuous Distributions	3	3
			Theoretical Continuous Distributions Practical Course	2	1
		7	Statistical Methods	3	3
			Statistical Methods Practical Course	2	1
		8	Inferential Statistics	3	3
			Inferential Statistics Practical Course	2	1
	IV	9	Sampling Techniques	3	3
			Sampling Techniques Practical Course	2	1
		10	Design and Analysis of Experiments	3	3
			Design and Analysis of Experiments Practical Course	2	1
		11	Numerical Analysis	3	3
			Numerical Analysis Practical Course	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
III	V	12	Applied Statistics	3	3
			Applied Statistics Practical Course	2	1
		13	Computational Statistics and R Programming	3	3

			Computational Statistics and R Programming Practical Course	2	1
		14 A	Operations Research	3	3
			Operations Research Practical Course	2	1
		OR			
		14 B	Statistical Quality Control	3	3
			Statistical Quality Control Practical Course	2	1
		15 A	Optimization Techniques	3	3
			Optimization Techniques Practical Course	2	1
		OR			
		15 B	Applied Statistics – II	3	3
			Applied Statistics – II Practical Course	2	1
	VI	**Internship**			
IV	VII	16 A	Advanced Operations Research	3	3
			Advanced Operations Research Practical Course	2	1
		OR			
		16 B	Actuarial Statistics	3	3
			Actuarial Statistics Practical Course	2	1
		17 A	Multivariate Analysis	3	3
			Multivariate Analysis Practical Course	2	1
		OR			
		17 B	Linear Models and Applied Regression Analysis	3	3
			Linear Models and Applied Regression Analysis Practical Course	2	1
		18 A	Advanced Sampling Techniques	3	3
			Advanced Sampling Techniques Practical Course	2	1
		OR			
		18 B	Stochastic Processes	3	3
			Stochastic Processes Practical Course	2	1
		SEC			
		19 A	Statistical Analysis of Clinical Trials	3	3
			Statistical Analysis of Clinical Trials Practical Course	2	1
		OR			
		19 B	Data Analysis using SPSS	3	3
			Data Analysis using SPSS Practical Course	2	1
		20 A	Basic Data Science Techniques	3	3
			Basic Data Science Techniques Practical Course	2	1
		OR			
		20 B	Modern Statistical Analysis	3	3
			Modern Statistical Analysis Practical Course	2	1
	VIII	21 A	Advanced Optimization Techniques	3	3
			Advanced Optimization Techniques Practical Course	2	1
		OR			

		21 B	Advanced Actuarial Statistics	3	3
			Advanced Actuarial Statistics Practical Course	2	1
		22 A	Advanced Design and analysis of Experiments	3	3
			Advanced Design and analysis of Experiments Practical Course	2	1
		OR			
		22 B	Linear Algebra	3	3
			Linear Algebra Practical Course	2	1
		23 A	Modern Inferential Statistics	3	3
			Modern Inferential Statistics Practical Course	2	1
		OR			
		23 B	Applied Probability and Distributions	3	3
			Applied Probability and Distributions Practical Course	2	1
		SEC			
		24 A	Statistical Techniques for Research Methodology	3	3
			Statistical Techniques for Research Methodology Practical Course	2	1
		OR			
		24 B	Biostatistics and Survival Analysis	3	3
			Biostatistics and Survival Analysis Practical Course	2	1
		25 A	Econometrics	3	3
			Econometrics Practical Course	2	1
		OR			
		25 B	Data Mining Techniques	3	3
			Data Mining Techniques Practical Course	2	1

SEMESTER-I

COURSE 1: ESSENTIALS AND APPLICATIONS OF MATHEMATICAL, PHYSICAL ANDCHEMICAL SCIENCES

Theory Credits: 4 5 hrs/week

Course Objective:

The objective of this course is to provide students with a comprehensive understanding of the essential concepts and applications of mathematical, physical, and chemical sciences. The course aims to develop students' critical thinking, problem-solving, and analytical skills in these areas, enabling them to apply scientific principles to real-world situations.

Learning outcomes:

1. Apply critical thinking skills to solve complex problems involving complex numbers, trigonometric ratios, vectors, and statistical measures.

2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations

3. To Explain the basic principles and concepts underlying a broad range of fundamental areas of chemistry and to Connect their knowledge of chemistry to daily life.

4. Understand the interplay and connections between mathematics, physics, and chemistry in various applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.

5 To explore the history and evolution of the Internet and to gain an understanding of network security concepts, including threats, vulnerabilities, and countermeasures.

UNIT I: ESSENTIALS OF MATHEMATICS:

Complex Numbers: Introduction of the new symbol i – General form of a complex number – Modulus-Amplitude form and conversions

Trigonometric Ratios: Trigonometric Ratios and their relations – Problems on calculation of angles**Vectors:** Definition of vector addition – Cartesian form – Scalar and vector product and problems **Statistical Measures**: Mean, Median, Mode of a data and problems

UNIT II: ESSENTIALS OF PHYSICS:

Definition and Scope of Physics- Measurements and Units - Motion of objects: Newtonian Mechanics and relativistic mechanics perspective - Laws of Thermodynamics and Significance- Acoustic waves and electromagnetic waves- Electric and Magnetic fields and their interactions- Behaviour of atomic and nuclear particles- Wave-particle duality, the uncertainty principle- Theories and understanding of universe

UNIT III: ESSENTIALS OF CHEMISTRY: :

Definition and Scope of Chemistry- Importance of Chemistry in daily life -Branches of chemistry and significance- Periodic Table- Electronic Configuration, chemical changes, classification of matter, Biomolecules- carbohydrates, proteins, fats and vitamins.

UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY:

Applications of Mathematics in Physics & Chemistry: Calculus , Differential Equations & Complex Analysis

Application of Physics in Industry and Technology: Electronics and Semiconductor Industry, Robotics and Automation, Automotive and Aerospace Industries, Quality Control and Instrumentation, Environmental Monitoring and Sustainable Technologies.

Application of Chemistry in Industry and Technology: Chemical Manufacturing, Pharmaceuticals and Drug Discovery, Materials Science, Food and Beverage Industry.

UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

Milestones of computer evolution - Internet, history, Internet Service Providers, Types of Networks, IP, Domain Name Services, applications.

Ethical and social implications: Network and security concepts- Information Assurance Fundamentals, Cryptography-Symmetric and Asymmetric, Malware, Firewalls, Fraud Techniques- Privacy and Data Protection

Recommended books:

1. Functions of one complex variable by John.B.Conway, Springer- Verlag.

2. Elementary Trigonometry by H.S.Hall and S.R.Knight

3.Vector Algebra by A.R.Vasishtha, Krishna Prakashan Media(P)Ltd.

4.Basic Statistics by B.L.Agarwal, New age international Publishers

5. University Physics with Modern Physics by Hugh D. Young and Roger A. Freedman

6. Fundamentals of Physics by David Halliday, Robert Resnick, and Jearl Walker

7. Physics for Scientists and Engineers with Modern Physics" by Raymond A. Serway and John W. Jewett Jr.

8. Physics for Technology and Engineering" by John Bird

9. Chemistry in daily life by Kirpal Singh

10. Chemistry of bio molecules by S. P. Bhutan

11. Fundamentals of Computers by V. Raja Raman

12. Cyber Security Essentials by James Graham, Richard Howard, Ryan Olson

STUDENT ACTIVITIES

UNIT I: ESSENTIALS OF MATHEMATICS:

1: Complex Number Exploration

Provide students with a set of complex numbers in both rectangular and polar forms.

They will plot the complex numbers on the complex plane and identify their properties

2: Trigonometric Ratios Problem Solving

Give students a set of problems that require the calculation of trigonometric ratios and their relations.

Students will solve the problems using the appropriate trigonometric functions (sine, cosine, tangent, etc.) and trigonometric identities.

3: Vector Operations and Applications

Provide students with a set of vectors in Cartesian form.

Students will perform vector addition and subtraction operations to find the resultant vectors.

They will also calculate the scalar and vector products of given vectors.

4: Statistical Measures and Data Analysis

Give students a dataset containing numerical values.

Students will calculate the mean, median, and mode of the data, as well as other statistical measures if appropriate (e.g., range, standard deviation).
They will interpret the results and analyze the central tendencies and distribution of the data.

UNIT II: ESSENTIALS OF PHYSICS:

1. Concept Mapping

Divide students into groups and assign each group one of the topics.

Students will create a concept map illustrating the key concepts, relationships, and applications related to their assigned topic.

Encourage students to use visual elements, arrows, and labels to represent connections and interdependencies between concepts.

2. Laboratory Experiment

Select a laboratory experiment related to one of the topics, such as motion of objects or electric and magnetic fields.
Provide the necessary materials, instructions, and safety guidelines for conducting the experiment.
Students will work in small groups to carry out the experiment, collect data, and analyze the results.

After the experiment, students will write a lab report summarizing their findings, observations, and conclusions.

UNIT III: ESSENTIALS OF CHEMISTRY

1: Chemistry in Daily Life Presentation

Divide students into groups and assign each group a specific aspect of daily life where chemistry plays a significant role, such as food and nutrition, household products, medicine,or environmental issues.
Students will research and create a presentation (e.g., PowerPoint, poster, or video) that showcases the importance of chemistry in their assigned aspect.
2: Periodic Table Exploration

Provide students with a copy of the periodic table.

Students will explore the periodic table and its significance in organizing elements based on their properties.
They will identify and analyze trends in atomic structure, such as electronic configuration, atomic size, and ionization energy.

3: Chemical Changes and Classification of Matter

Provide students with various substances and chemical reactions, such as mixing acids and bases or observing a combustion reaction.
Students will observe and describe the chemical changes that occur, including changes in color, temperature, or the formation of new substances.
4: Biomolecules Investigation

Assign each student or group a specific biomolecule category, such as carbohydrates,proteins, fats, or vitamins.
Students will research and gather information about their assigned biomolecule category, including its structure, functions, sources, and importance in the human body.

They can create informative posters or presentations to present their findings to the class.

UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

1: Interdisciplinary Case Studies

Divide students into small groups and provide them with interdisciplinary case studies that involve the interdisciplinary application of mathematics, physics, and chemistry.

Each case study should present a real-world problem or scenario that requires the integration of concepts from all three disciplines.

2: Design and Innovation Project

Challenge students to design and develop a practical solution or innovation that integrates mathematics, physics, and chemistry principles.

Students can choose a specific problem or area of interest, such as renewable energy, environmental conservation, or materials science.
3: Laboratory Experiments

Assign students laboratory experiments that demonstrate the practical applications of mathematics, physics, and chemistry.

Examples include investigating the relationship between concentration and reaction rate, analyzing the behavior of electrical circuits, or measuring the properties of materials.

.4: Mathematical Modeling

Present students with real-world problems that require mathematical modeling and analysis.

UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

1. Identifying the attributes of network (Topology, service provider, IP address and bandwidth of
2. your college network) and prepare a report covering network architecture.
3. Identify the types of malwares and required firewalls to provide security.
4. Latest Fraud techniques used by hackers**.**

SEMESTER-I

COURSE 2: ADVANCES IN MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES

Theory Credits: 4 5 hrs/week

Course Objective:

The objective of this course is to provide students with an in-depth understanding of the recent advances and cutting-edge research in mathematical, physical, and chemical sciences. The course aims to broaden students' knowledge beyond the foundational concepts and expose them to the latest developments in these disciplines, fostering critical thinking, research skills, and the ability to contribute to scientific advancements.

Learning outcomes:

1. Explore the applications of mathematics in various fields of physics and chemistry, to understand how mathematical concepts are used to model and solve real-world problems.

2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations.

3. Understand the different sources of renewable energy and their generation processes and advances in nanomaterials and their properties, with a focus on quantum dots. To study the emerging field of quantum communication and its potential applications. To gain an understanding of the principles of biophysics in studying biological systems. Explore the properties and applications of shape memory materials.

3. Understand the principles and techniques used in computer-aided drug design and drug delivery systems, to understand the fabrication techniques and working principles of nanosensors. Explore the effects of chemical pollutants on ecosystems and human health.

4. Understand the interplay and connections between mathematics, physics, and chemistry in various advanced applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.

5 Understand and convert between different number systems, such as binary, octal, decimal, and hexadecimal. Differentiate between analog and digital signals and understand their characteristics.Gain knowledge of different types of transmission media, such as wired (e.g., copper cables, fiber optics) and wireless (e.g., radio waves, microwave, satellite)..

UNIT I: ADVANCES IN BASICS MATHEMATICS

Straight Lines: Different forms – Reduction of general equation into various forms – Point ofintersection of two straight lines

Limits and Differentiation: Standard limits – Derivative of a function –Problems on product ruleand quotient rule

Integration: Integration as a reverse process of differentiation – Basic methods of integration

Matrices: Types of matrices – Scalar multiple of a matrix – Multiplication of matrices – Transpose ofa matrix and determinants

UNIT II: ADVANCES IN PHYSICS:

Renewable energy: Generation, energy storage, and energy-efficient materials and devices. **Recent advances in the field of nanotechnology**: Quantum dots, Quantum Communication- recent advances in biophysics- recent advances in medical physics- Shape Memory Materials.

UNIT III: ADVANCES IN CHEMISTRY:

Computer aided drug design and delivery, nano sensors, Chemical Biology, impact of chemical pollutants on ecosystems and human health, Dye removal - Catalysis method

UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

Mathematical Modelling applications in physics and chemistry

Application of Renewable energy: Grid Integration and Smart Grids,

Application of nanotechnology: Nanomedicine,

Application of biophysics: Biophysical Imaging, Biomechanics, Neurophysics,

Application of medical physics: Radiation Therapy, Nuclear medicine

Solid waste management, Environmental remediation- Green Technology, Water treatment.

UNIT V: Advanced Applications of computer Science

Number System-Binary, Octal, decimal, and Hexadecimal, Signals-Analog, Digital, Modem, Codec, Multiplexing, Transmission media, error detection and correction- Parity check and CRC, Networking devices- Repeater, hub, bridge, switch, router, gateway.

Recommended books:

1. Coordinate Geometry by S.L.Lony, Arihant Publications
2. Calculus by Thomas and Finny, Pearson Publications
3. Matrices by A.R.Vasishtha and A.K.Vasishtha, Krishna Prakashan Media(P)Ltd.
4. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
5. "Energy Storage: A Nontechnical Guide" by Richard Baxter
6. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and Raghvendra A. Bohara
7. "Biophysics: An Introduction" by Rodney Cotterill
8. "Medical Physics: Imaging" by James G. Webster
9. "Shape Memory Alloys: Properties and Applications" by Dimitris C. Lagoudas
10. Nano materials and applications by M.N.Borah

11. Environmental Chemistry by Anil.K.D.E.

12. Digital Logic Design by Morris Mano

13. Data Communication & Networking by Bahrouz Forouzan.

STUDENT ACTIVITIES

UNIT I: ADVANCES IN BASIC MATHEMATICS

1: Straight Lines Exploration

Provide students with a set of equations representing straight lines in different forms, suchas slope-intercept form, point-slope form, or general form.

Students will explore the properties and characteristics of straight lines, including theirslopes, intercepts, and point of intersection.

2: Limits and Differentiation Problem Solving

Students will apply the concept of limits to solve various problems using standard limits.

Encourage students to interpret the results and make connections to real-world applications,such as analyzing rates of change or optimizing functions.

3: Integration Exploration

Students will explore the concept of integration as a reverse process of differentiation andapply basic methods of integration, such as the product rule, substitution method, or integration by parts.

Students can discuss the significance of integration in various fields, such as physics andchemistry

4: Matrices Manipulation

Students will perform operations on matrices, including scalar multiplication, matrixmultiplication, and matrix transpose.

Students can apply their knowledge of matrices to real-world applications, such as solvingsystems of equations or representing transformations in geometry.

UNIT II: ADVANCES IN PHYSICS:

1: Case Studies

Provide students with real-world case studies related to renewable energy, nanotechnology,biophysics, medical physics, or shape memory materials.

Students will analyze the case studies, identify the challenges or problems presented, andpropose innovative solutions based on the recent advances in the respective field.

They will consider factors such as energy generation, energy storage, efficiency, sustainability, materials design, biomedical applications, or technological advancements.

2: Experimental Design

Assign students to design and conduct experiments related to one of the topics: renewableenergy, nanotechnology, biophysics, medical physics, or shape memory materials.

They will identify a specific research question or problem to investigate and design anexperiment accordingly.

Students will collect and analyze data, interpret the results, and draw conclusions based ontheir findings.

They will discuss the implications of their experimental results in the context of recentadvances in the field.

3: Group Discussion and Debate

Organize a group discussion or debate session where students will discuss the ethical, social, and environmental implications of the recent advances in renewable energy, nanotechnology, biophysics, medical physics, and shape memory materials.

Assign students specific roles, such as proponent, opponent, or moderator, and provide them with key points and arguments to support their positions.

UNIT III: ADVANCES IN CHEMISTRY:

1. Experimental Design and Simulation

In small groups, students will design experiments or simulations related to the assigned topic.

For example, in the context of computer-aided drug design, students could design a virtualscreening experiment to identify potential drug candidates for a specific disease target.

For nano sensors, students could design an experiment to demonstrate the sensitivity andselectivity of nano sensors in detecting specific analytes.
Chemical biology-related activities could involve designing experiments to study enzyme-substrate interactions or molecular interactions in biological systems.
Students will perform their experiments or simulations, collect data, analyze the results, and draw conclusions based on their findings.

2. Case Studies and Discussion

Provide students with real-world case studies related to the impact of chemical pollutants onecosystems and human health.
Students will analyze the case studies, identify the sources and effects of chemical pollutants,and propose mitigation strategies to minimize their impact.

Encourage discussions on the ethical and environmental considerations when dealing withchemical pollutants.
For the dye removal using the catalysis method, students can explore case studies wherecatalytic processes are used to degrade or remove dyes from wastewater.

Students will discuss the principles of catalysis, the advantages and limitations of thecatalysis method, and its applications in environmental remediation.
3: Group Project

Assign students to work in groups to develop a project related to one of the topics.

The project could involve designing a computer-aided drug delivery system, developing anano sensor for a specific application, or proposing strategies to mitigate the impact of chemical pollutants on ecosystems.
Students will develop a detailed project plan, conduct experiments or simulations, analyzedata, and present their findings and recommendations.
Encourage creativity, critical thinking, and collaboration throughout the project.

UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS &CHEMISTRY
1: Mathematical Modelling Experiment

Provide students with a mathematical modelling experiment related to one of the topics. Forexample, in the context of renewable energy, students can develop a mathematical model tooptimize the placement and configuration of solar panels in a solar farm.
Students will work in teams to design and conduct the experiment, collect data, and analyzethe results using mathematical models and statistical techniques.
They will discuss the accuracy and limitations of their model, propose improvements, and

interpret the implications of their findings in the context of renewable energy or the specific application area.

2: Case Studies and Group Discussions

Assign students to analyze case studies related to the applications of mathematical modelling in nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.

Students will discuss the mathematical models and computational methods used in the case studies, analyze the outcomes, and evaluate the effectiveness of the modelling approach.

Encourage group discussions on the challenges, ethical considerations, and potential advancements in the field.

Students will present their findings and engage in critical discussions on the advantages and limitations of mathematical modelling in solving complex problems in these areas.

3. Group Project

Assign students to work in groups to develop a group project that integrates mathematical modelling with one of the application areas: renewable energy, nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.

The project could involve developing a mathematical model to optimize the delivery of radiation therapy in medical physics or designing a mathematical model to optimize waste management practices.

Students will plan and execute their project, apply mathematical modelling techniques, analyze the results, and present their findings and recommendations.

Encourage creativity, critical thinking, and collaboration throughout the project.

UNIT V: Advanced Applications of computer Science

Students must be able to convert numbers from other number system to binary number systems

1. Identify the networking media used for your college network

   Identify all the networking devices used in your college premises.

SEMESTER-II
COURSE 3: DESCRIPTIVE STATISTICS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To acquaint with the role of statistics in different fields with special reference to business and economics.
2. To review good practice in presentation and the format most applicableto their own data.
3. To learn the measures of central tendency or averages reduce the data to a single value which is highly useful for making comparative studies.
4. To familiar with the measures of dispersion throw light on reliability of average and control of variability.
5. To deal with the situation where there is uncertainty and to measure that uncertainty by using the probability, which is essential in all research areas.

II. Syllabus

Unit – 1: Statistical Description of Data

Origin, history and definitions of Statistics. Importance, Scope and limitations Statistics. Function of Statistics – Collection, Presentation, Analysis and Interpretation. Collection of data - primary and secondary data and its methods. Classification of data – Quantitative, Qualitative, Temporal, Spatial. Presentation of data – Textual, Tabular – essential parts.

Unit – 2:

Measurement Scales – Nominal, Ordinal, Ratio and Interval. Frequency distribution and types of frequency distributions, forming a frequency distribution. Diagrammatic representation of data – Historiagram, Bar, Multiple bar and Pie with simple problems. Graphical representation of data: Histogram, frequencypolygon and Ogives with simple problems.

Unit – 3: Measures of Central Tendency (MCT)

Arithmetic Mean – properties, methods. Median, Mode, Geometric Mean (GM), Harmonic Mean (HM). Calculation of mean, median, mode, GM and HM for grouped and ungrouped data. Median and Mode through graph. Empirical relation between mean, media and mode. Features of good average.

Unit – 4: Measures of Dispersion

Concept and problems – Range, Quartile Deviation, Mean Deviation and Standard Deviation, Variance. Central and Non – Central moments and their interrelationship. Sheppard's correction for moments. Skewness and its methods, kurtosis.

Unit – 5: Elementary Probability

Basic Concepts of Probability, random experiments, trial, outcome, sample space, event, mutually exclusive and exhaustive events, equally likely and favourable outcomes. Mathematical, Statistical, axiomatic definitions of probability. Conditional Probability and independence of events, Addition and multiplication theorems of probability for 2 and for n events and simple problems. Boole's inequality, Bayes theorem and its applications in real life problems.

SEMESTER-II
COURSE 3: DESCRIPTIVE STATISTICS

Practical Credits: 1 2 hrs/week

Syllabus

1. Writing a Questionnaire in different situations.
2. Forming a grouped and ungrouped frequency distribution table.
3. Diagrammatic presentation of data – Bar, multiple Bar and Pie.
4. Graphical presentation of data – Histogram, frequency polygon, Ogives.
5. Computation of measures of central tendency – Mean, Median and Mode.
6. Computation of measures of dispersion – Q.D., M.D and S.D.
7. Computation of non-central, central moments, β_1 and β_2 for ungrouped data.
8. Computation of non-central, central moments, β_1 and β_2 and Sheppard's corrections for grouped data.
9. Computation of Karl Pearson's and Bowley's Coefficients of Skewness.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

III. References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
2. O. P. Gupta: Mathematical Statistics, Kedar nath Ram nath & Co.
3. P. N. Arora & S. Arora: Quantitative Aptitude Statistics – Vol II, S. Chand & Company Ltd.
4. K. Rohatgi & Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley & Sons.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc. on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-II

COURSE 4: RANDOM VARIABLES AND MATHEMATICAL EXPECTATIONS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To acquaint with the role of statistics in dealing with the univariate random variables.
2. To learn the extension of the univariate data to bivariate data.
3. To learn the measure of randomness mathematically by using expectations.
4. To get the familiarity about the generating functions, law of large numbers and central limit theorem, further to apply in research and allied fiends.

II. Syllabus

Unit – 1: Univariate Random Variables

Definition of random variable (r.v.), discrete and continuous random variables, functions of random variable. Probability mass function, Probability density function, Distribution function and its properties. Calculation of moments, coefficient of skewness and kurtosis for a given pmf and pdf.

Unit – 2: Bivariate Random Variables

Bivariate random variable - meaning, joint, marginal and conditional Distributions, independence of random variables and simple problems.

Unit – 3: Mathematical Expectation

Mathematical expectation of function a random variable. Moments and covariance using mathematical expectation with examples. Addition and Multiplication theorems on expectation. Properties of expectations, variance, covariance. Chebyshev and Cauchy - Schwartz inequalities and their applications

Unit – 4: Generating functions

Definitions of Moment Generating Function, Cumulant Generating Function, Characteristic Function and Probability Generating Function and their properties. Weak Law of Large Numbers (WLLN), Strong Law of Large Numbers (SLLN).

Unit – 5: Limit Theorems

Concept – Population, Sample, Parameter, statistic, Sampling distribution, Standard error. Convergence in probability and convergence in distribution, concept of Central limit theorem. Lindberg – Levy CLT and its applications, Statement of Lyapunov's CLT, relationship between CLT and WLLN.

SEMESTER-II

COURSE 4: RANDOM VARIABLES AND MATHEMATICAL EXPECTATIONS

Practical Credits: 1 2 hrs/week

Syllabus

1. Calculation of moments of univariate random variable to the given pmf.
2. Calculation of coefficient of skewness and kurtosis of univariate random variable to the given pmf.
3. Calculation of moments of univariate random variable to the given pdf.
4. Calculation of coefficient of skewness and kurtosis of univariate random variable to the given pdf.
5. Problem related to jpmf, mpmf and conditional pmf and its independence.
6. Problem related to jpdf, mpdf and conditional pdf and its independence.
7. Chebyshev's inequality application oriented problems.

III. References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
2. O. P. Gupta: Mathematical Statistics, Kedar nath Ram nath & Co.
3. P. N. Arora & S. Arora: Quantitative Aptitude Statistics – Vol II, S. Chand & Company Ltd.
4. K. Rohatgi & Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley & Sons.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc. on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-III

COURSE 5: THEORETICAL DISCRETE DISTRIBUTIONS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To deal with the data by the basic discrete distributions such as Uniform and Binomial distributions.
2. To acquaint the Poisson distribution applications.
3. To learn about the Negative Binomial distribution and its applications towards the real life problems.
4. To familiar with dealing the data by Geometric and Hyper Geometric distributions.

II. Syllabus

Unit – 1: Uniform, Bernoulli and Binomial distributions

Discrete Uniform distribution – definitions, mean, variance. Bernoulli distribution – definitions, mean, variance and its mgf. Binomial distribution – Definition, moments, M.G.F, C.F, C.G.F, P.G.F, additive property if exists, skewness, kurtosis and problems. First two moments obtained through mgf, recurrence relation for probabilities, limiting case of Binomial Distribution to Normal distribution.

Unit – 2: Poisson Distribution

Poisson distribution - Definition, moments, M.G.F, C.F, C.G.F, P.G.F, additive property if exists, skewness, kurtosis and problems. First two moments obtained through mgf, recurrence relation for probabilities. Poisson distribution as a limiting case of Binomial distribution, limiting case of Poisson Distribution to Normal distribution.

Unit – 3: Negative Binomial Distribution

Negative Binomial Distribution - Definition, moments, M.G.F, C.F, C.G.F, P.G.F, additive property if exists, skewness, kurtosis and problems. First two moments obtained through mgf, recurrence relation for probabilities. Limiting case of Negative Binomial Distribution to Normal distribution.

Unit – 4: Geometric Distribution

Geometric Distribution – Definition, moments, M.G.F, C.F, C.G.F, P.G.F, additive property if exists, skewness, kurtosis and problems. First two moments obtained through mgf, Lack of memory property. Recurrence relation for probabilities.

Unit – 5: Hyper Geometric Distribution

Hyper Geometric Distribution – Definition, mean and variance, problems. Recurrence relation for probabilities. Limiting case of Hyper Geometric distribution to Binomial distribution.

SEMESTER-III

COURSE 5: THEORETICAL DISCRETE DISTRIBUTIONS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Fitting of Binomial distribution – Direct method.
2. Fitting of Binomial distribution – Recurrence relation Method.
3. Fitting of Poisson distribution – Direct method.
4. Fitting of Poisson distribution - Recurrence relation Method.
5. Fitting of Negative Binomial distribution – Direct method.
6. Fitting of Negative Binomial distribution – Recurrence relation Method.
7. Fitting of Geometric distribution – Direct method.
8. Fitting of Geometric distribution – Recurrence relation Method.
9. Fitting of Hyper Geometric distribution.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

III. Text Books/References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
2. O. P. Gupta: Mathematical Statistics, Kedar nath Ram nath & Co.
3. P. N. Arora & S. Arora: Quantitative Aptitude Statistics – Vol II, S. Chand & Company Ltd.
4. K. Rohatgi & Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley & Sons.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-III

COURSE 6: THEORETICAL CONTINUOUS DISTRIBUTIONS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To deal with the data by the basic continuous distribution such as Uniform Binomial distribution.
2. To acquaint the Exponential distribution applications.
3. To learn about the Gamma and Beta distributions and their applications towards the real life problems.
4. To get familiarity of the most important distributions such as Normal and Standard Normal distribution and their applications in research and various fields.
5. To acquire the knowledge of exact sampling distributions.

II. Syllabus

Unit – 1: Continuous Uniform distribution

Uniform distribution – Definition, moments, M.G.F, C.F, C.G.F, skewness, kurtosis and Distribution function. Mean Deviation about mean.

Unit – 2: Exponential Distribution

Exponential distribution – Definition, moments, M.G.F, C.F, C.G.F, skewness, kurtosis and Distribution function. Memory less property.

Unit – 3: Gamma and Beta Distributions

Gamma Distribution - Definition, moments, M.G.F, C.F, C.G.F, skewness, kurtosis and additive property. Limiting form of gamma distribution.

Beta Distribution of first and second kind – Definition, mean, variance and harmonic mean.

Unit – 4: Normal Distribution

Normal Distribution – Definition, properties, importance, M.G.F, C.F, C.G.F, additive property, skewness, kurtosis and problems. Obtain mean, median and mode, Even and Odd order moments about mean, linear combination of normal variates, points of inflexion of normal probability curve.

Unit – 5: Standard Normal and Sampling Distributions

Standard Normal Distribution – Definition, mgf, mean and variance, Area property, problems. Student's t- distribution, F – Distribution, χ^2- Distribution: Definitions, properties and their applications.

SEMESTER-III

COURSE 6: THEORETICAL CONTINUOUS DISTRIBUTIONS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Calculation of moments of Uniform distribution.
2. Calculation of skewness and kurtosis of Uniform distribution.
3. Fitting of Exponential distribution.
4. Gamma distribution application oriented problems.
5. Fitting of Normal distribution – Areas method.
6. Fitting of Normal distribution – Ordinates method.
7. Problems related to Standard Normal distribution.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

III. Text Books/References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
2. O. P. Gupta: Mathematical Statistics, Kedar nath Ram nath & Co.
3. P. N. Arora & S. Arora: Quantitative Aptitude Statistics – Vol II, S. Chand & Company Ltd.
4. K. Rohatgi & Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley & Sons.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-III
COURSE 7: STATISTICAL METHODS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To get the knowledge of estimating future values by using curve fitting.
2. To calculate the relationship between bivariate data.
3. To find the relationship about the multivariate data.
4. To acquaint about the forecasting of the data by using regression techniques.
5. To find the association of the categorical data by using attributes.

II. Syllabus

Unit – 1: Curve fitting

Bivariate data, Principle of least squares, fitting of k^{th} degree polynomial. Fitting of straight line, Fitting of Second degree polynomial or parabola, fitting of family of exponential curves and power curve.

Unit – 2: Correlation

Meaning, Types of Correlation, Measures of Correlation – Scatter diagram, Karl Pearson's Coefficient of Correlation, Rank Correlation Coefficient (with and without ties), Properties. Bivariate frequency distribution, correlation coefficient for bivariate data and problems. Lag and Lead in correlation.

Unit – 3:

Coefficient of concurrent deviation, probable error and its properties, coefficient of determination, Concept of multiple and partial correlation coefficients (three variables only), properties and problems, intra-class correlation and correlation ratio.

Unit – 4: Regression

Concept of Regression, Linear and Non Linear regression. Linear Regression – Regression lines, Regression coefficients and it properties, Angle between two lines of regression. Regressions lines for bivariate data and simple problems. Correlation vs regression. Explained and Unexplained variations.

Unit – 5: Attributes

Notations, Class, Order of class frequencies, Ultimate class frequencies, Consistency of data, Conditions for consistency of data for 2 and 3 attributes only , Independence of attributes , Association of attributes and its measures, Relationship between association and colligation of attributes, Contingency table: Square contingency**,** Mean square contingency, Coefficient of mean square contingency, Tschuprow's coefficient of contingency.

SEMESTER-III

COURSE 7: STATISTICAL METHODS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Fitting of straight line by the method of least squares
2. Fitting of parabola by the method of least squares
3. Fitting of exponential curve of two types by the method of least squares.
4. Fitting of power curve of the type by the method of least squares.
5. Computation of correlation coefficient and regression lines for ungrouped data.
6. Computation of correlation coefficient for bivariate frequency distribution.
7. Computation of correlation coefficient, forming regression lines for grouped data.
8. Computation of partial and multiple correlation coefficients.
9. Computation of Yule's coefficient of association and colligation.
10. Computation of Pearson's, Tschuprow's coefficient of contingency.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

III. References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
2. O. P. Gupta: Mathematical Statistics, Kedar nath Ram nath & Co.
3. P. N. Arora & S. Arora: Quantitative Aptitude Statistics – Vol II, S. Chand & Company Ltd.
4. K. Rohatgi & Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley & Sons.

IV. Suggested Co-curricular Activities:

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2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
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SEMESTER-III

COURSE 8: INFERENTIAL STATISTICS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To acquaint with estimator, estimates, estimation techniques and its properties.
2. To acquire knowledge of testing the hypothesis of different distributions.
3. To learn about the large sample techniques by using various tools.
4. To learn about the small sample techniques by using various tools.
5. To deal with the situation where there is no parameters to the distributions.

II. Syllabus

Unit – 1: Theory of estimation

Estimation of a parameter, criteria of a good estimator – unbiasedness, consistency, efficiency, & sufficiency. Statement of Neyman's factorization theorem. Estimation of parameters by the method of moments and maximum likelihood (M.L), properties of MLE's. Rao – Cramer Inequality, properties. Binomial, Poisson & Normal Population parameters estimate by MLE method. Confidence Intervals.

Unit – 2: Testing of Hypothesis

Concepts of statistical hypotheses, null and alternative hypothesis, critical region, two types of errors, level of significance and power of a test. One and two tailed tests. Neyman-Pearson's lemma. Examples in case of Binomial, Poisson, Exponential and Normal distributions.

Unit – 3: Large sample Tests

Large sample test for single mean and difference of two means, confidence intervals for mean(s). Large sample test for single proportion, difference of proportions. standard deviation(s) and correlation coefficient(s**).**

Unit – 4: Small Sample tests

Assumptions and t-test for single mean, difference of means and paired t-test. χ^2 test for goodness of fit and independence of attributes. χ^2 test for single variance, F-test for equality of variances.

Unit – 5: Non-parametric tests

Advantages and disadvantages, comparison with parametric tests. One sample runs test, sign test and Wilcoxon – signed rank tests (single and paired samples). Two independent sample tests: Median test, Wilcoxon – Mann – Whitney U test, Wald Wolfowitz's runs test**.**

SEMESTER-III
COURSE 8: INFERENTIAL STATISTICS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Large sample test for single mean
2. Large sample test for difference of means
3. Large sample test for single proportion
4. Large sample test for difference of proportions
5. Large sample test for difference of standard deviations
6. Large sample test for correlation coefficient
7. Small sample test for single mean
8. Small sample test for difference of means
9. Small sample test for correlation coefficient
10. Paired t-test (paired samples).
11. Small sample test for single variance (χ^2 test)
12. Small sample test for difference of variances (F test)
13. χ^2 test for goodness of fit and independence of attributes
14. Nonparametric tests for single sample(run test, sign test and Wilcoxon signed rank test)
15. Nonparametric tests for related samples (sign test and Wilcoxon signed rank test)
16. Nonparametric tests for two independent samples (Median test, Wilcoxon –Mann- Whitney - U test, Wald - Wolfowitz' s runs test)

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

III. References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
2. O. P. Gupta: Mathematical Statistics, Kedar nath Ram nath & Co.
3. P. N. Arora & S. Arora: Quantitative Aptitude Statistics – Vol II, S. Chand & Company Ltd.
4. K. Rohatgi & Ehsanes Saleh: An Introduction to Probability and Statistics, John Wiley & Sons.

IV. Suggested Co-curricular Activities:

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2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
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7. Visits/field trips of firms, research organizations etc.

SEMESTER-IV
COURSE 9: SAMPLING TECHNIQUES

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To review about the population and its concepts also methods to collect data and errors to deal.
2. Introduced to various statistical sampling schemes such as simple, stratified and systematic sampling.
3. An idea of conducting the sample surveys and selecting appropriate sampling techniques.
4. Knowledge about comparing various sampling techniques.
5. To use appropriate factorial experimental to analyze the experimental data.

II. Syllabus

Unit – 1:
Brief review of parameter and statistic, sampling distribution. Principal steps and principles in a sample survey, sampling and non – sampling errors, advantages of sampling over census, limitations, types of sampling – concept of subjective, probability and mixed sampling.

Unit – 2: Simple Random Sampling (with and without replacement)
Notations and terminology, various probabilities of selection. Random numbers tables and its uses. Methods of selecting simple random sample, lottery method, method based on random numbers. Estimates of population total, mean and theirvariances and standard errors, determination of sample size, simple random sampling of attributes.

Unit – 3: Stratified random sampling
Stratified random sampling, Advantages and Disadvantages of StratifiedRandom sampling, Estimation of population mean, and its variance. Stratified random sampling with proportional and optimum allocations. Comparison between proportional and optimum allocations with SRSWOR.

Unit – 4: Systematic sampling
Systematic sampling definition when N = nk and merits and demerits of systematic sampling - estimate of mean and its variance. Comparison of systematic sampling with Stratified and SRSWOR. Comparison of variance of SRS, StRS and SYS for a linear trend. Concept of Cluster Sampling, Multistage Sampling and Quota Sampling.

Unit – 5: National and International Official Statistical System
National Statistical Organization: vision and mission, NSSO and CSO, roles and responsibilities, important activities, publications etc.
National Statistical Commission: Need, Constitution, its role, functions, important acts.

SEMESTER-IV
COURSE 9: SAMPLING TECHNIQUES

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Show the sample mean is unbiased estimator of population mean in SRSWOR and also find variance of sample mean.
2. Show the sample mean square is unbiased estimator of population mean square in SRSWOR.
3. Show the sample mean is unbiased estimator of population mean in SRSWR and also find variance of sample mean.
4. Compare means and variances between SRSWR and SRSWOR.
5. Allocation of sample sizes to various strata in proportional and in optimum allocations to draw a Stratified random sample.
6. Compare precision in proportional and optimum allocations with SRSWOR and gain in efficiency due to proportional and optimum allocations.
7. Systematic sampling with N = nk and Compare the precision of an estimate in systematic sampling with that of in Stratified and in SRSWOR.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

III. References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Applied Statistics, Sultan Chand&Sons, New Delhi.
2. K.V.S. Sarma: Statistics Made Simple: Do it yourself on PC. PHI.
3. M. R. Saluja: Indian Official Statistics. ISI publications.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-IV

COURSE 10: DESIGN AND ANALYSIS OF EXPERIMENTS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

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

1. To acquaint with the role of statistics in different fields with special reference to agriculture.
2. Learn to apply the one of the design of experiment to agricultural fields.
3. Learn to apply the randomization to the blocks of various fields in agriculture.
4. To get the familiarity about applications of three principles.
5. Learn to deal the agricultural fields with different factors and levels.
6. To use appropriate experimental designs to analyze the experimental data.

II. Syllabus

Unit – 1: Analysis of variance (ANOVA)

Concept, Definition and assumptions. ANOVA one way classification – mathematical model, analysis – with equal and unequal classification. ANOVA two way classification – mathematical model, analysis and problems.

Unit – 2: Completely Randomised Design (CRD)

Definition, terminology, Principles of design of experiments, CRD – Concept, advantages and disadvantages, applications, Layout, Statistical analysis. Critical Differences when hypothesis is significant.

Unit – 3: Randomised Block Design (RBD)

Concept, advantages and disadvantages, applications, Layout, Statistical analysis and Critical Differences. Efficiency of RBD relative to CRD. RBD with one missing value and its analysis, problems.

Unit – 4: Latin Square Design

Concept, advantages and disadvantages, applications, Layout, Statistical analysis and Critical Differences. Efficiency of LSD over RBD and CRD. Estimation of one missing value in LSD and its analysis, problems.

Unit – 5: Factorial experiments

Main effects and interaction effects of 2^2 and 2^3 factorial experiments and their Statistical analysis. Yates procedure to find factorial effect totals.

SEMESTER-IV

COURSE 10: DESIGN AND ANALYSIS OF EXPERIMENTS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. ANOVA - one - way classification with equal number of observations.
2. ANOVA - one - way classification with unequal number of observations.
3. ANOVA Two-way classification.
4. Analysis of CRD and critical differences.
5. Analysis of RBD and critical differences. Relative efficiency of CRD with RBD.
6. Estimation of single missing observation in RBD and its analysis.
7. Analysis of LSD and efficiency of LSD over CRD and RBD.
8. Estimation of single missing observation in LSD and its analysis.
9. Analysis of 2^2 with RBD layout.
10. Analysis of 2^3 with RBD layout.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

V. References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Applied Statistics, Sultan Chand&Sons, New Delhi.
2. K.V.S. Sarma: Statistics Made Simple: Do it yourself on PC. PHI.
3. M. R. Saluja: Indian Official Statistics. ISI publications.

VI. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-IV

COURSE 11: NUMERICAL ANALYSIS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course the student will be able

1. Learn the different difference operators and applications.
2. Accustom with the interpolation techniques with equal and unequal intervals.
3. Able to use numerical differentiation tools.
4. Familiar to use numerical integration methods.

II. Syllabus

Unit 1

Definitions of Forward difference operator (Δ), Backward difference operator, Shift or Extension (displacement) operator (E), Central Differences operator(μ), Differentiation operator(D), Mean value operator Symbolic relations between operators, properties of difference and shift operators, fundamental theorem on finite differences and simple problems.

Unit 2

Interpolation with equal intervals: Concept of interpolation and extrapolation, assumptions and uses of interpolation, difference tables, methods of interpolation with equal intervals - Newton's formula for forward and backward interpolation, Central differences, Gauss forward and backward, Sterling, Bessel's and Laplace - Everett's Formulae.

Unit 3

Interpolation with unequal intervals: Divided differences and their properties. Methods of interpolation with unequal intervals – Newton's Divided difference formula and Lagrange's formula. Inverse interpolation - Lagrange's formula.

Unit 4

Numerical Differentiation: Introduction to Numerical differentiation. Determination of First and Second order derivatives for the given data using Newton's forward and backward, Gauss forward and backward, Sterling, Bessel's and Newton's Divided difference formula.

Unit 5

Numerical Integration: Introduction to numerical integration, General Quadrature formula for equidistant ordinates, Trapezoidal rule, Simpson's $1/3^{rd}$, Simpson's $3/8^{th}$ rule and Weddle's rule.

SEMESTER-IV

COURSE 11: NUMERICAL ANALYSIS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Interpolation by using Newton-Gregory forward and backward difference formulae.
2. Interpolation by using Gauss forward and backward difference formulae.
3. Interpolation by using Sterling and Bessel's formulae.
4. Interpolation by using Laplace-Everett's Formula.
5. Interpolation by using Newton's divided difference and Lagrange's formulae.
6. Inverse interpolation by using Lagrange's formula.
7. Determination of first and second order derivatives by using Newton-Gregory forward and backward difference formulae.
8. Determination of first and second order derivatives by using Gauss forward and backward difference formulae.
9. Determination of first and second order derivatives by using Newton's divided difference formula.
10. Numerical Integration by using Trapezoidal rule, Simpson's $1/3^{rd}$, Simpson's $3/8^{th}$ rule and Weddle's rule.

III. References

1. H. C. Saxena: Finite Differences and Numerical Analysis, S. Chand and Company, New Delhi.
2. P. P. Gupta, G. S. Malik & Sanjay Gupta: Calculus of Finite Differences and Numerical Analysis, Krishna Prakashan Media(P) Ltd., Meerut(UP), India.
3. S. S. Sastry: Introductory Methods Numerical Analysis, Prentice- Hall of India.
4. C. F. Gerald and P. O. Wheatley: Applied Numerical Analysis, Addison- Wesley, 1998.

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1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
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SEMESTER-V
COURSE 12: APPLIED STATISTICS

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course, the student will be able to know about

1. Forecasting Techniques and its applications.
2. Interpret and use a range of index numbers commonly used in the business sector.
3. Perform calculations involving simple and weighted index numbers.
4. Understand the basic structure of the Consumer price index and perform calculations involving its use.
5. Various data collection methods enabling to have a better insight in policy making, planning andsystematic implementation,
6. Construction and implementation of life tables.
7. Population growth curves, population estimates and projections,
8. Real data implementation of various demographic concepts as outlined above through practical assignments.

II. Syllabus

Unit – 1: Time Series

Time Series and its components with illustrations, additive, multiplicative and mixed models. Trend – Estimation of trend by free hand curve method, method of Semi Averages. Determination of trend by Leastsquares (Linear trend, parabolic trend only), Moving averages method.

Unit – 2: Seasonal Component

Determination of seasonal indices by Simple Averages method, Ratio to Moving Average, Ratio to Trend and Link Relative methods, Deseasonalization.

Unit – 3: Index numbers

Concept, construction, problems involved in the construction of index numbers, uses and limitations. Simple and Weighted index numbers – Various Weighted Aggregate Index numbers, Criterion of a good index number, Fisher's ideal index number. Cost of living index number and Wholesale price index number.

Unit – 4: Vital Statistics

Introduction, definition, and uses of vital statistics, sources of vital statistics. Measures of Mortality Rates – Crude Death Rate, Specific Death Rate, Standardised Death Rate with different populations and problems.

Unit – 5:

Life table – Columns, Construction and Uses of Life table, Proofs of life table functions. Measures of Fertility Rates – Crude Birth Rate, General Fertility Rate, Specific Fertility Rate, Total Fertility Rate. Measures of population growth – Pearls, Gross Reproduction Rate, Net Reproduction Rate and its problems.

SEMESTER-V
COURSE 12: APPLIED STATISTICS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Measurement of trend by method of moving averages (odd and even period)
2. Measurement of trend by method of Least squares (linear and parabola)
3. Determination of seasonal indices by method simple averages
4. Determination of seasonal indices by method of Ratio to Moving Averages
5. Determination of seasonal indices by method of Ratio to Trend
6. Determination of seasonal indices by method of Link relatives
7. Computation of simple index numbers.
8. Computation of all weighted index numbers.
9. Computation of reversal tests.
10. Computation of various Mortality rates
11. Computation of various Fertility rates
12. Computation of various Reproduction rates.
13. Construction of Life Table.

III. References

1. Fundamentals of Applied Statistics: V. K. Kapoor & S. C. Gupta.
2. Mukopadhyay, P (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied Pvt. Ltd.
3. Brockwell, P.J. and Devis, R.A. (2003): Introduction to Time Series Analysis. Springer.
4. Chatfield, C. (2001): Time Series Forecasting., Chapman & Hall.
5. Srinivasan, K. (1998): Demographic Techniques and Applications. Sage Publications
6. Srivastava O.S. (1983): A Text Book of Demography. Vikas Publishing House.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
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7. Visits/field trips of firms, research organizations etc.

SEMESTER-V

COURSE 13: COMPUTATIONAL STATISTICS AND R PROGRAMMING

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course the student will be able

1. Be comfortable using commercial and open source tools such as the R language and its associated libraries for data analytics and visualization.
2. Learn skills to analyze real time problems using R
3. Able to use basic R data structures in loading, cleaning the data and preprocessing the data.
4. Able to do the exploratory data analysis on real time datasets
5. Able to understand and implement Linear Regression
6. Able to understand and use - lists, vectors, matrices, data frames, etc

II. Syllabus

Unit – 1: Computer basics

Basic applications of computer, components of computer system, Central Processing Unit (CPU), input and output units, computer memory and mass storage devices. Programming languages and their applications. Concept of files and folders. Software and types of software. Operating System like Windows and Linux.

Unit – 2: Data processing

Data processing using spreadsheets – Data entry and editing features in Excel, copy, paste, paste special options, sort and filter options, auto sum, steps of finding average and standard deviation of data using statistical functions. Matrix operations like transpose, multiply and inverse using Excel functions. Simple graphs like bar chart, line chart and pie chart in Excel. Exporting Excel output to word processers like MS-Word and slide presentations like Power Point.

Unit – 3:

Scatter diagram, fitting of straight line, polynomial and power curves using Excel – Reading R-square value and equation from the graph. Predicting future values using 'forecast' and 'trend' functions. Data Analysis Pak and its features. Performing Student's t-test and one- way Analysis of Variance using Data Analysis Pak. P-value and its interpretation.

Unit – 4: R Programming

Introduction to R, Features of R – Environment – R Studio. Basics of R-Assignment - Modes - Operators - special numbers - Logical values - Basic Functions - R help functions - R Data Structures - Control Structures. Vectors: Definition- Declaration - Generating - Indexing - Naming - Adding & Removing elements - Operations on Vectors - Recycling - Special Operators - Vectorized if- then else-Vector Equality – Functions for vectors - Missing values - NULL values - Filtering & Subsetting.

Unit – 5:

Matrices - Creating Matrices, Adding or Removing rows/columns, Operations. Creating Data Frames, Naming, Accessing, Adding, and Removing, Applying Special functions to Data Frames, Merging Data Frames Factors and Tables.

Exploratory Data Analysis – Descriptive Statistics – Central Tendency - Variability - Mean - Median - Range - Variance - Summary - Handling Missing values and Outliers - Normalization Data Visualization in R : Types of visualizations - packages for visualizations - Basic Visualizations, Advanced Visualizations and Creating 3D plots.

SEMESTER-V

COURSE 13: COMPUTATIONAL STATISTICS AND R PROGRAMMING

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Installing R and R studio
2. Create a folder DS_R and make it a working directory. Display the current working directory
3. installing the "ggplot2", "caTools", "CART" packages
4. load the packages "ggplot2", "caTools".
5. Basic operations in r
6. Working with Vectors:
   a) Create a vector v1 with elements 1 to 20.
   b) Add 2 to every element of the vector v1.
   c) Divide every element in v1 by 5.
   d) Create a vector v2 with elements from 21 to 30. Now add v1 to v2.
7. Using the data present in the table given below, create a Matrix "M"

	C1	C2	C3	C4	C5
C1	0	12	13	8	20
C2	12	0	15	28	88
C3	13	15	0	6	9
C4	8	28	6	0	33
C5	20	88	9	33	0

   Find the pairs of cities with shortest distance.
8. Consider the following marks scored by the 6 students

Section	Student	M1	M2	M3
A	1	46	54	45
A	2	34	55	55
A	3	56	66	64
B	1	43	44	45
B	2	67	76	78
B	3	76	68	37

   a) create a data structure for the above data and store in proper positions with proper names
   b) display the marks and totals for all students
   c) Display the highest total marks in each section.
   d) Add a new subject and fill it with marks for 2 sections.
9. Three people denoted by P1, P2, P3 intend to buy some rolls, buns, cakes and bread. Each of them needs these commodities in differing amounts and can buy them in two shops S1, S2. The individual prices and desired quantities of the commodities are given in the following table

	Price						
	S1	S2		Demand.quantity			
Roll	1.5	1		Roll	Bun	Cake	Bread
Bun	2	2.5	P1	6	5	3	1
Cake	5	4.5	P2	3	6	3	2
Bread	16	17	P3	3	4	3	1

a) Create matrices for above information with row names and col names.
b) Display the demand. quantity and price matrices
c) Find the total amount to be spent by each person for their requirements in each shop
d) Suggest a shop for each person to buy the products which is minimal.

10. Applying summary() to find the mean, median, standard deviation, etc
11. Implementation of Visualizations - Bar, Histogram, Box, Line, scatter plot, etc.

III. References

1. Chambers, J. (2008). Software for Data Analysis: Programming with R, Springer.
2. Crawley, M.J. (2017). The R Book, John Wiley & Sons.
3. Matloff, N. (2011). The Art of R Programming, No Starch Press, Inc.
4. Dr. Mark Gardener(2012): Beginning R The statistical Programming Languages, John Wiley & Sons.
5. Sudha G. Purohit, SharadD.Gore, and ShailajaR.Deshmukh (2008), Statistics Using R, Narosa Publishing House, India.
6. Mark Gardener, "Beginning R - The Statistical Programming Language", John Wiley & Sons, Inc., 2012.
7. W. N. Venables, D. M. Smith and the R Core Team, "An Introduction to R", 2013.
8. Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics", Wiley, 2011.
9. Nina Zumel, John Mount, "Practical Data Science with R", Manning Publications, 2014.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-V

COURSE 14A: OPERATIONS RESEARCH

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course, the student will be able

1. To know the scope of Operations Research
2. To link the OR techniques with business environment and life sciences
3. To convert real life problems into mathematical models
4. To find a solution to the problem in different cases
5. To inculcate logical thinking to find a solution to the problem

II. Syllabus

Unit – 1:

Introduction of OR – Origin and development of OR – Nature and features of OR –Scientific Method in OR – Modeling in OR – Advantages and limitations of Models-General Solution methods of OR models – Applications of Operation Research. Linear Programming problem (LPP) – Mathematical formulation of the problem - illustrations on Mathematical formulation of Linear Programming of problem.

Unit – 2:

Graphical solution of linear Programming problems with maximizing and minimizing objective function up to 3 variables. Finding convex hull and non-convex hull of LPP. Some exceptional cases - Alternative solutions, Unbounded solutions, non-existing feasible solutions by Graphical method.

Unit – 3:

General linear Programming Problem(GLP) – Definition and Matrix form of GLP problem, Slack variable, Surplus variable, unrestricted Variable, Standard form of LPP and Canonical form of LPP. Definitions of Solution, Basic Solution, Degenerate Solution, Basic feasible Solution and Optimum Basic Feasible Solution. Introduction to Simplex method and Computational procedure of simplex algorithm. Solving LPP by Simplex method (Maximization case and Minimization case up to three variables only)

Unit – 4:

Artificial variable technique - Big-M method and Two-phase simplex method, Degeneracy in LPP and method to resolve degeneracy. Alternative solution, Unbounded solution, Non existing feasible solution and Solution of simultaneous equations by Simplex method.

Unit – 5:

Duality in Linear Programming –Concept of duality -Definition of Primal and Dual Problems, General rules for converting any primal into its Dual, Relation between the solution of Primal and Dual problem (statements only). Using duality to solve primal problem. Dual Simplex Method.

SEMESTER-V
COURSE 14A: OPERATIONS RESEARCH

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. To solve Linear Programming Problem using Graphical Method with
    i. Unbounded solution
    ii. Infeasible solution
2. Solution of LPP with simplex method.
3. Problem solving using Big M - method.
4. Problem solving using Two Phase method.
5. Illustration of following special cases in LPP using Simplex method
    iii. Unbounded solution
    iv. Alternative or multiple solutions.
6. Problems based on Principle of Duality.
7. Problems based on Dual simplex method.

III. References

1. S.D. Sharma: Operations Research, Kedar Nath Ram Nath & Co, Meerut.
2. Kanti Swarup, P.K.Gupta, Manmohn: Operations Research, Sultan Chand and sons, NewDelhi.
3. J.K. Sharma: Operations Research and Application, Mc.Millan and Company, New Delhi.
4. Gass S.I: Linear Programming. Mc Graw Hill.
5. Hadly G: Linear Programming. Addison-Wesley.
6. Taha H.M: Operations Research: An Introduction : Mac Millan.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-V

COURSE 14B: STATISTICAL QUALITY CONTROL

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course, the student will be able

1. To define 'quality' in a scientific way
2. To differentiate between process control and product control
3. To speak about quality awareness in industry
4. To pave a path to an industry to meet the standards
5. To effectively implement various plans to control the quality standards at variousstages of an industry.

II. Syllabus

Unit – 1:

Importance of SQC – 4 M's of SQC, causes of variation – Assignable and chance cause of variation, uses, process and product control, Control charts technique, Statistical basis of Shewhart control charts.

Unit – 2: Control charts for Variables

Introduction and Construction of Mean and Range chart; Mean and Standard Deviation Chart when standards are specified and unspecified, corrective action if the process is out of statistical control.

Unit – 3: Control charts for Attributes

Introduction and Construction of fraction defective chart, number of defectives chart, no. of defects per unit Chart and U charts when standards are specified and unspecified, corrective action if theprocess is out of statistical control.

Unit – 4:

Acceptance Sampling for Attributes: Introduction, Concept of sampling inspection plan, Comparison between 100% inspection and sampling inspection. Procedures of acceptance sampling with rectification, Producer's risk and Consumer's risk, Operating characteristic (OC) curve, Acceptable Quality Level (AQL), Lot Tolerance Fraction Defective (LTFD) and Lot Tolerance percent Defective (LTPD), Average Outgoing Quality (AOQ) and Average Outgoing Quality Limit (AOQL), AOQ curve, Average Sample Number (ASN), Average Total Inspection (ATI).

Unit – 5:

Single Sampling Plan: Computation of probability of acceptance using Binomial and Poisson approximation, of AOQ and ATI. Graphical determination of AOQL, Determination of a single sampling plan by: a) lot quality approach b) average quality approach.

SEMESTER-V

COURSE 14B: STATISTICAL QUALITY CONTROL

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Construction of Mean and R Charts.
2. Construction of Mean and Standard deviation charts.
3. Construction of p Chart for fixed sample size.
4. Construction of p Chart for variable sample size.
5. Construction of np Chart.
6. Construction of C chart.
7. Construction of U chart.
8. Single sampling plan for attributes (OC Curve, Producer's and Consumer's risks, AOQ, AOQL, ATI).
9. Determination of single sampling plan by: a) lot quality approach b) average quality approach.

III. References

1. Montgomery, D. C. (2008): Statistical Quality Control, 6th Edn., John Wiley, New York.
2. Parimal Mukhopadhyay: Applied Statistics, New Central Book Agency.
3. Goon A.M., Gupta M.K. and Das Gupta B. (1986): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
4. S.C. Gupta and V.K. Kapoor: Fundamentals of Applied Statistics – Chand publications.
5. R.C. Gupta: Statistical Quality Control.
6. Duncan A.J. (1974): Quality Control and Industrial Statistics, fourth edition
7. D.B. Taraporewala Sons and Co. Pvt. Ltd., Mumbai.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-V

COURSE 15A: OPTIMIZATION TECHNIQUES

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course, the student will be able

1. To solve the problems in logistics
2. To find a solution for the problems having space constraints
3. To minimize the total elapsed time in an industry by efficient allocation of jobs to the suitable persons.
4. To find a solution for an adequate usage of human resources
5. To find the most plausible solutions in industries and agriculture when a randomenvironment exist.

II. Syllabus

Unit – 1:

Transportation Problem- Introduction, Mathematical formulation of Transportation problem. Definition of Initial Basic feasible solution of Transportation problem- North-West corner rule, Lowest cost entry method, Vogel's approximation method. Method of finding optimal solution- MODI method(U-V method). Degeneracy in transportation problem, Resolution of degeneracy, Unbalanced transportation problem. Maximization of TP.

Unit – 2:

Assignment Problem -Introduction, Mathematical formulation of Assignment problem, Reduction theorem (statement only), Hungarian Method for solving Assignment for both balanced and unbalanced Assignment Problems.

Unit – 3:

Sequencing problem: Introduction and assumptions of sequencing problem, Sequencing of n jobs and one machine problem. Johnson's algorithm for n jobs and two machines problem- problems with n-jobs on two machines, algorithm for n jobs on three machines problem- problems with n- jobs on three machines, algorithm for n jobs on m machines problem, problems with n-jobs on m- machines.

Unit – 4:

GameTheory:Two-personzero-sumgames.PureandMixedstrategies.Maxmin and Minimax Principles - Saddle point and its existence. Games without Saddle point-Mixed strategies. Solution of 2 x 2 rectangular games. Graphical method of solving 2 x n and m x 2 games. Dominance Property. Matrix oddment method for n x n games. Only formulation of Linear Programming Problem for m x n games.

Unit – 5:

Network Scheduling: Basic Components of a network, nodes and arcs, events and activities– Rules of Network construction – Time calculations in networks - Critical Path method (CPM) and PERT.

SEMESTER-V
COURSE 15A: OPTIMIZATION TECHNIQUES

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. IBFS of transportation problem by using North- West corner rule, Matrixminimum method and VAM
2. Optimum solution to balanced and unbalanced transportation problems by MODI method(both maximization and minimization cases)
3. Solution of Assignment problem using Hungarian method (both maximization andminimization cases),
4. Solution of sequencing problem—processing of n jobs through two machines
5. Solution of sequencing problem- processing of n jobs through three machines
6. To perform Project scheduling of a given project (Deterministic case-CPM).
7. To perform Project scheduling of a given project (Probabilistic case-PERT).
8. Solution of m x n games by dominance rule.

III. References

1. S.D. Sharma: Operations Research, Kedar Nath Ram Nath & Co, Meerut.
2. Kanti Swarup, P.K.Gupta, Manmohan: Operations Research, Sultan Chand and sons, NewDelhi.
3. J.K. Sharma: Operations Research and Application, Mc. Millan and Company, New Delhi.
4. Gass: Linear Programming. Mc Graw Hill.
5. Hadly: Linrar Programming. Addison-Wesley.
6. Taha: Operations Research: An Introduction : Mac Millan.
7. Dr. NVS Raju: Operations Research, SMS education.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
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7. Visits/field trips of firms, research organizations etc.

SEMESTER-V

COURSE 15B: APPLIED STATISTICS II

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course, the student will be able to know about

1. Different growth curves and its methods to construct, expertise with growth curves.
2. Interpret and use a range of index numbers methods commonly used in the business sector.
3. Understand the basic structure of the Demand analysis and perform calculations, involving its use.
4. Calculation of different scores specific to Psychological and Educational statistics.
5. Accustom various methods to calculation test reliability and test scores.

II. Syllabus

Unit – 1: Growth curves

Modified exponential curve, Logistic curve and Gompertz curve, fitting of growth curves by the method of three selected points and partial sums. Detrending. Effect of elimination of trend on other components of the time series.

Unit – 2: Index Numbers

Base shifting, calculation of index numbers with different bases – Fixed base and Chain base, splicing of index numbers series, Deflating the Index numbers. Index number of Industrial production, Interim Index number of Industrial production, Revised Index number of Industrial production.

Unit – 3: Demand Analysis

Introduction, price Elasticity of demand, partial Elasticities of demand, types of data required for estimating Elasticities, Leontief's method, Pigou's method (from time series data), Pigou's method (from family budget data), Engel's curve and Engel's law, Pareto's law of income distribution, Formulation of the problem, Curves of concentration.

Unit – 4: Psychological and Educational Statistics

Introduction, scaling individual test items in terms of difficulty (sigma scaling), scaling of scores on a test, Z score and Z scaling, standard scores, normalized scores, T-scores, percentile scores, scaling of rankings in terms of normal probability curve and scaling of ratings in terms of normal curve.

Unit – 5:

In Reliability of test scores, error variance or standard error of measurement, index of reliability, parallel tests, method of determining test reliability (the test-retest method, the Rulon method of estimating reliability, method of rational equivalence or Kuder-Richardson formula), validity of test scores, calculation of validity, validity and test length, comparison between reliability and validity, and intelligence quotient.

SEMESTER-V

COURSE 15B: APPLIED STATISTICS II

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Fitting of modified exponential curve (using method of three selected points)
2. Fitting of modified exponential curve (using method of partial sums)
3. Fitting of Gompertz curve (using method of three selected points)
4. Fitting of Gompertz curve (using method of partial sums)
5. Fitting of Logistic curve (using method of partial sums)
6. Finding index numbers by shifting the base.
7. Calculation of Fixed and Chain base index numbers.
8. Splicing two index number series.
9. Deflating index number.
10. Calculation of income and price elasticities.
11. Fitting of Pareto's curve to the given data.
12. Calculation of test reliability using the difficulty values of items and S.D of the total scores and mean and S.D of the total scores.

III. References

1. Fundamentals of applied statistics: VK Kapoor and SC Gupta.
2. Mukopadhyay, P (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied Pvt. Ltd.
3. Brockwell, P.J. and Devis, R.A. (2003): Introduction to Time Series Analysis. Springer.
4. Chatfield, C. (2001): Time Series Forecasting., Chapman & Hall.
5. Srinivasan, K. (1998): Demographic Techniques and Applications. Sage Publications
6. Srivastava O.S. (1983): A Text Book of Demography. Vikas Publishing House.

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
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6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-VII

COURSE 16 A: ADVANCED OPERATIONS RESEARCH

Theory Credits: 3 3 hrs/week

I. Learning Outcomes

After learning this course, the student will be able

1. To know the Revised simplex method and its applications.
2. To formulate the data into different formats.
3. To convert real life problems into integer linear Programming problems.
4. To find a solution to the problem with different methods.
5. To inculcate knowledge about the guidelines towards getting patents and rights, which is useful in research.

II. Syllabus

Unit I: Revised Simplex Method

Introduction, Standard forms for Revised Simplex Method, formulation of LPP in standard form – I, Notations form standard form – I, To obtain inverse of initial basis matrix and IBFS – when no artificial variables are needed, to construct the starting table in standard form – I, application of computational procedure of standard form – I. Examples and solutions on standard form – I.

Unit II:

Formulation of LPP in Standard form – II, notations and basis matrix in standard form – II, computational procedure for standard form – II, advantages and disadvantages, examples and solutions on standard form – II.

Unit III: Integer Linear Programming Problem (ILPP)

Introduction and importance of IPP, Gomory's all Integer Programming technique, Gomory's cutting plane algorithm, short cut method for constructing the Gomory's constraint and computational problems on Gomory's method. Geometrical interpretation of Gomorys cutting plane method.

Unit IV: Integer Linear Programming Problem (ILPP)

Branch and Bound method, its algorithm, computational problems on Branch and Bound method, Geometrical interpretation of Branch and Bound method.

Unit V: Patents and Intellectual Property Right

Introduction, Patent, Provisional Specification, Complete specification, Copy right, Design, Trade mark.

SEMESTER-VII

COURSE 16 A: ADVANCED OPERATIONS RESEARCH

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Solutions of Revised simplex method of standard form I
2. Solutions of Revised simplex method of standard form II
3. Solutions of general Integer Programming problem
4. Geometrical interpretation of Gomory's cutting place method of IPP
5. Branch and Bound technique to solve IPP
6. Geometrical interpretation of Branch and Bound method of IPP

III. References

1. S. D. Sharma(2012): Operations Research, Kadar Nath Ram Nath Publications.
2. Chong, E. K. P. and Zak, S. (2004). An Introduction to Optimization, Wiley.
3. Fletcher, R. (2000). Practical Methods of Optimization,Wiley.
4. Hadley, G. (1987). Linear Programming. Addison-Wesley.
5. Hiller, F.S. and Lieberman, G.J., (2009). Introduction to Operations Research (9th ed.), McGraw-Hill
6. Panneerselvam, R. (2012). Operations Research, 2nd Edn. Prentice Hall of India.
7. Taha, H. A. (2016) Operations Research: An Introduction, 10th edition, Prentice Hall

IV. Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

SEMESTER-VII

COURSE 16 B: ACTUARIAL STATISTICS

Theory Credits: 3 3 hrs/week

I. Syllabus

UNIT I

Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory.

UNIT II

Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.

UNIT III

Survival Distribution and Life Tables: Uncertainty of age at death, survival function, time until – death for a person, curate future lifetime, force of mortality, life tables with examples, deterministic survivorship group, life table characteristics, assumptions for fractional age, some analytical laws of mortality.

UNIT IV

Life Insurance: Models for insurance payable at the moment of death, insurance payable at the end of the year of death and their relationships.

UNIT V

Life annuities: continuous life annuities, discrete life annuities, life annuities with periodic payments. Premiums: continuous and discrete premiums.

SEMESTER-VII
COURSE 16 B: ACTUARIAL STATISTICS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Risk computation for different utility models
2. Discrete and continuous risk calculations
3. Calculation of aggregate claims for collective risks
4. Calculation of aggregate claim for individual risks
5. Computing Ruin probabilities and aggregate losses
6. Annuity and present value of contract
7. Computing premium for different insurance schemes
8. Practical based on life models and tables

II. References

1. Dickson, C. M. D. (2005): Insurance Risk And Ruin (International Series On Actuarial Science), Cambridge University Press.
2. Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A. And Nesbitt, C. J. (1997): Actuarial Mathematics, Society Of Actuaries, Itasca, Illinois, U.S.A.

SEMESTER-VII

COURSE 17 A: MULTIVARIATE ANALYSIS

Theory Credits: 4 5 hrs/week

I. Syllabus

Unit I: Multivariate Analysis

Introduction - Application of Multivariate techniques – Organisation of Multivariate data –Derivation of Bi-variate and multivariate normal distributions and its properties - Determination of mean vector and covariance matrix of Multivariate Normal Distribution - The mean vector and covariance matrix for Linear combinations of Random Variables – The maximum likelihood estimators of the mean vector and covariance matrix of Multivariate Normal Distribution.

Unit II: Wishart Distribution

Introduction - Characteristic function and properties of Wishart Distribution. Generalized T-Square Statistic: Introduction – Derivation of the Generalized T-Square Statistic (Hotelling T Square) distribution – uses – applications. Hotelling T Square and Likelihood Ratio Tests.

Unit III: Multiple Linear Regression

Introduction –Classical Linear Regression Model – Least Square Estimators - Inferences about the Regression Model – Inferences from the Estimated Regression Function – Model Checking and Other Aspects of Regression – Multivariate Multiple Regression.

Unit IV:

Principal Components: Objectives – Population Principal Components – Extraction of Principal Components.

Factor Analysis: Introduction – Model Description (The Orthogonal Factor Model) – Methods of estimation – Factor rotation - Factor Scores – Perspectives and a strategy for Factor Analysis.

Unit V:

Discriminant Analysis: Objectives and assumptions - Fisher's Discriminant Function - Problem of Classification with Two or More Populations.

Cluster Analysis: Objectives – Assumptions - Research design – Formation of clusters – Clustering algorithm.

II. References

1. Anderson T.W, (2011): An Introduction to Multivariate Statistical Analysis: Wiley India Pvt. Ltd, New Delhi (Third Edition)
2. Kshirsagar, A. M. (1983): Multivariate Analysis, Marcel Dekker
3. Morrison, D.F. (1990): Multivariate Statistical Methods, McGraw Hill Co.
4. Rao, C. R. (1995): Linear Statistical Inference and its Applications,WileyEastern
5. Timm, N. H. (2002): Applied Multivariate Analysis, Springer, New York
6. Giri, N.C.(1977): Multivariate statistical inference, Academic Press

SEMESTER-VII

COURSE 17 B: LINEAR MODELS AND APPLIED REGRESSION ANALYSIS

Theory Credits: 4 5 hrs/week

I. Syllabus

UNIT I

Two and Three variable Linear Regression models; General linear model: Assumptions; OLS estimation; BLUE; Tests of significance of individual regression coefficients; Testing the equality between two regressions coefficients; Test of significance of complete regression.

UNIT II

Criteria for model selection; Goodness of fit measures; R^2 and adjusted R^2 Criteria; Cp criterion; testing the general linear hypothesis; Chow test for Equality between sets of regression coefficients in two linear models; test for structural change; restricted least squares estimation; Generalized Mean Squared error criterion.

UNIT III

Non-normal disturbances and their consequences; test for normality; Jarque-Bera test; Shapiro-Wilk test, Minimum Absolute Deviation (MAD) estimation; Box-Cox transformations.

UNIT IV

Statistical analysis of residuals, OLS residuals, BLUS residual, Studentised residual, predicted residual, tests against heteroscedasticity.

UNIT V

Non-Linear regression; Nonlinear least squares estimation; Maximum Like Hood Estimation; Idea of computational methods; Gradient methods, Steepest descent method and Newton-Raphson method.

II. References

1. Johnston, J (1984): Econometric Methods, III rd edition. MC Graw Hill.
2. Gujarathi, D (1979): Basic Econometrics, MC Graw Hill.
3. Judge, C.G., Griffiths, R.C.Hill, W.E ., Lutkephol, H and Lee, T.C (1985): The Theory and Practice of Econometrics, John Wiley and Sons.
4. Draper, N and Smith, B (1981): Applied Regression Analysis, Second Edition

SEMESTER-VII

COURSE 18 A: ADVANCED SAMPLING TECHNIQUES

Theory Credits: 4 5 hrs/week

I. Syllabus

Unit I:

Review of basic terminology such as population, sample, parameter and statistics, sampling distribution, standard error, Simple Random Sampling (SRS), Stratified Random Sampling (StRS) and Systematic Sampling.

Unit II:

Review of basic concepts of sampling theory such as sampling design, sampling scheme, sampling strategy etc., Sampling with varying probability with and without replacement, PPS WR/WOR methods – Lahiri's sample scheme, Hansen – Hurwitz, Des Raj estimators for a general sample size and Murthy estimator for a sample of size 2, Symmentrized Des Raj estimator.

Unit III:

Hurwitz – Thompson estimator (HTE) of a finite population total / mean, expression for V (HTE) and its unbiased estimator. IPPS scheme of a sampling due to Midzuno – Sen and JNK Rao (sample size 2 only). Rao – Hartley-Cochran sampling scheme for a sample of size n with random grouping.

Unit IV:

Ratio and Regression methods of estimation, Two stage sampling, Multi stage sampling, Cluster sampling. Resampling methods and its applications.

Unit V:

Double sampling for difference, ratio, regression and PPS estimators; Large scale sample surveys, Errors in surveys, A mathematical model for errors of measurement, Sampling and Non-sampling errors, Sources and types of non-sampling errors, Remedies for non-sampling errors.

II. References

1. Chaudhuri. A and Mukerji. R (1988): Randomized Response Theory and Techniques, NewYork, Marcel Dekker Inc.
2. Cochran W.G (1988): Sampling Techniques III Edition (1977) Wiley.
3. Des Raj and Chandak (1988): Sampling Theory. Narosa.
4. Murthy M.N (1977): Sampling Theory and Methods. Statistical Publishing Society.
5. Sukhatme et al (1984): Sampling Theory of Surveys with Applications. Iowa State University Press & IARS.
6. Sing D and Chudary F.S (1986): Theory and Analysis of Sample Survey Designs. New Age International Publishers.
7. Hedayat A.S and Sinha B.K. (1991): Design and Inference in Finite Population Sampling. Wiley.
8. Mukhopadhyay P(1996): Inferential problems in Survey Sampling. New Age International.

SEMESTER-VII
COURSE 18 B: STOCHASTIC PROCESSES

Theory Credits: 4 5 hrs/week

I. Syllabus

UNIT I
Introduction to Stochastic processes, classification of stochastic processes according to state space and time domain. Countable state Markov Chains, Chapman Kolmogorov equations, calculation of n-step transition probability and its limit. Classification of states, period of a state, Stationary distribution of Markov Chains.

UNIT II
Random walk and gamble's ruin problem, Random walk in one and two dimensions, Gambler's ruin problem, and probability of ultimate ruin, expected duration of the game.

UNIT III
Discrete state space, continuous time Markov Chain, Poisson process and its properties, birth process, death process and birth and death process.

UNIT IV
Wiener process as a limit of random walk and some elementary properties of Wiener process. Branching process: Galton – Watson branching process, probability of ultimate extinction, distribution of population size.

UNIT V
Renewal theory: Elementary renewal theorem and applications. Study of residual and excess life times and their distributions. Stationary process: weakly stationary and strongly stationary processes.

II. References

1. Medhi J. (1994): Stochastic Processes. 2nd Ed, New Age, New Delhi.
2. Bhat, B.R. (2000): Stochastic Models: Analysis and Applications, New Age International Indi
3. Basu, A.K.(2003): Introduction to Stochastic Process, Narosa Publishing House, Chennai.
4. Srinivasan S.K. and Mehta K.M. (1981): Stochastic Process.
5. Adke, S.R. and Manjunath, S.M. (1984): An Introduction to Finite Markov Processes, Wiley Eastern.
6. Feller, W. (1968): Introduction to Probability and its Applications, Vol. I, Wiley Eastern.

SEMESTER-VII

COURSE 19 A: STATISTICAL ANALYSIS OF CLINICAL TRIALS

Theory Credits: 3 3 hrs/week

I. Syllabus

Unit I

Introduction to clinical trials: need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, multi-center trials. Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.

Unit II

Determination of sample size: for two independent samples of Dichotomous Response variables, for two independent samples of Continuous Response variables and for repeated variables.

Unit III

Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, objectives and endpoints of clinical trials, design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.

Unit IV

Reporting and analysis: analysis of categorical outcomes from Phase I - III trials, analysis of survival data from clinical trials.

Unit V

Surrogate end points: selection and design of trials with surrogate end points, analysis of surrogate end point data. Meta-analysis of clinical trials.

SEMESTER-VII

COURSE 19 A: STATISTICAL ANALYSIS OF CLINICAL TRIALS

Practical Credits: 1 2 hrs/week

Practical Syllabus

1. Determination of Sample size
2. Multiple Logistic Regression with two or Three variables
3. Analysis of Clinical trial data using Crossover design
4. Analysis of Clinical trial data using Parallel design
5. Meta-analysis of Clinical trials

II. References

1. S.Piantadosi(1997): Clinical Trials: A Methodological Perspective. Wiley and Sons.
2. C.Jennison and B.W.Turnbull(1999): Group Sequential Methods with Applications to Clinical Trials, CRC Press.
3. L.M.Friedman, C.Furburg,D.L. Demets(1998): Fundamentals of Clinical Trials, Springer Verlag.
4. J.L.Fleiss(1989): The Design and Analysis of Clinical Experiments. Wiley and Sons.
5. E.Marubeni and M.G.Valsecchi(1994): Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.
6. Chow S.C. and Liu J.P. (2004): Design and Analysis of Clinical Trials. 2nd Ed. Marcel Dekkar.
7. Fleiss J. L. (1989): The Design and Analysis of Clinical Experiments, Wiley.

SEMESTER-VII

COURSE 19 B: DATA ANALYSIS USING SPSS

Theory Credits: 4 5 hrs/week

I. Syllabus

UNIT I:

Data handling: open SPSS data file – save – import from other data source – data entry – labelling for dummy numbers - recode in to same variable – recode in to different variable – transpose of data – insert variables and cases – merge variables and cases.

UNIT II:

Data handling: Split – select cases – compute total scores – table looks – Changing column - font style and sizes

UNIT III:

Diagrammatic representation: Simple Bar diagram – Multiple bar diagram – Sub-divided Bar diagram - Percentage diagram - Pie Diagram – Frequency Table – Histogram – Scatter diagram – Box plot.

UNIT IV:

Descriptive Statistics - Mean, Median, Mode, SD - Skewness- Kurtosis. Correlation – Karl Pearson's and Spearman's Rank Correlation, Regression analysis: Simple and Multiple Regression Analysis [Enter and stepwise methods]

UNIT V:

Testing of Hypothesis: Parametric – One sample – Two sample independent t – test – Paired t – test. Chi - square test. Analysis of variance: One way and Two-way ANOVA.

II. References

1. Clifford E. Lunneborg (2000). Data analysis by resampling: concepts and applications. Dusbury Thomson learning. Australia.
2. Everitt, B.S and Dunn, G (2001). Applied multivariate data analysis. Arnold London.
3. Jeremy J. Foster (2001). Data analysis using SPSS for windows. New edition. Versions 8-10. Sage publications. London.
4. Michael S. Louis – Beck (1995). Data analysis an introduction, Series: quantitative applications in the social sciences. Sage. Publications. London.

SEMESTER-VII

COURSE 20 A: BASIC DATA SCIENCE TECHNIQUES

Theory Credits: 4 5 hrs/week

I. Syllabus

UNIT – I: Introduction to Data Science

Definition – Big Data and Data Science, Why data science – The Current Landscape, Who is Data Scientist?, Data Science Process Overview – Defining goals – Retrieving data – Data preparation – Data exploration – Data modeling – Presentation.

UNIT – II: Big Data

Problems when handling large data, General techniques for handling large data, Case study, Steps in big data, Distributing data storage and processing with Frameworks – Case study.

UNIT – III: Machine Learning

Machine learning, Modeling Process, Training model, Validating model, Predicting new observations, Supervised learning algorithms, Unsupervised learning algorithms.

UNIT – IV: Deep Learning

Introduction, Deep Feed forward Networks, Regularization, Optimization of Deep Learning, Convolutional Networks, Recurrent and Recursive Nets, Applications of Deep Learning.

UNIT – V: Data Visualization

Introduction to data visualization, Data visualization options, Filters, Map Reduce, Dash board development tools, Creating an interactive dashboard with dc.js – summary.

II. References

1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, ManningPublications Co., 1st edition, 2016
2. Deep Learning, Ian Good fellow, Yoshua Bengio, Aaron Courville, MIT Press, 1st edition, 2016
3. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O' Reilly, 1st edition, 2018
4. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015
5. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1st edition, 2013
6. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman,Cambridge University Press, 2nd edition, 2014

SEMESTER-VII

COURSE 20 B: MODERN STATISTICAL ANALYSIS

Theory Credits: 3 3 hrs/week

I. Syllabus

UNIT I

Data reduction, sufficiency, sufficient partition, Neyman factorization theorem, minimal sufficiency, completeness, Ancillarity and Basu's theorem, One-parameter exponential family, Multi-parameter exponential family and Pitman family of distributions, Canonical form, convexity property, minimal sufficiency and completeness

UNIT II

Unbiased Estimator, estimability of parametric functions, Cramer-Rao inequality, uniformly minimum variance unbiased estimators, Rao-Blackwell and Lehmann Scheffe theorems.

Unit III

Confidence sets and intervals, shortest expected length confidence intervals, relation with testing of hypotheses. Test function, MP tests, Neyman- Pearson lemma, UMP tests, nonexistence of UMP tests MLR property.

Unit IV

Consistent and asymptotically normal (CAN) estimators for real and vector valued parameters, invariance property under continuous transformation, methods for generating CAN estimators for real and vector valued parameters using method of moments and method of percentiles.

Comparison of consistent estimators, minimum sample size required by the estimator to attain certain level of accuracy

Unit V

Maximum Likelihood Estimation, restricted parameter space, Inconsistent MLEs, MLEs in irregular cases.

Asymptotic distribution of MLE in special class of distributions: Cramer regularity conditions, Cramer-Huzur bazar theorem, Extension to vector-valued parameters,

Asymptotic theory of tests of hypotheses: Tests based on MLEs. Likelihood ratio tests, asymptotic distribution of log likelihood ratio, Bartlett correction, Wald test, Score test, Pearson's chi-square test and LR test, Consistent Test.

SEMESTER-VII

COURSE 20 B: MODERN STATISTICAL ANALYSIS

Practical Credits: 1 2 hrs/week

Syllabus

1. Calculation of descriptive statistics (central tendency) using SPSS
2. Calculation of dispersion using SPSS
3. Construction of data visualization – tables, charts using SPSS
4. Construction of simple regression lines
5. Construction of multiple regression lines
6. Problems on UMP tests
7. Calculation of consistent estimator
8. Problems on LR tests
9. Wald test
10. Score test
11. Pearson's Chi-Square test

II. References

1. Casella, G. and Berger ,R.L.(2002): Statistical Inference. Duxbury Advanced Series, SecondEdition.
2. Efron, B. and Hastie, T. (2016): Computer Age Statistical Inference: Algorithms, Evidence and Data Science. Cambridge University Press
3. Ferguson, T.S. (1996): A Course in Large Sample Theory, Chapman & Hall, London
4. Gupta Anirban Das (2008): Asymptotic Theory of Statistics and Probability, Springer
5. Lehmann, E. L. and Romano, J. (2005): Testing Statistical Hypotheses,Springer
6. Rao, C. R. (1995): Linear Statistical Inference and its Applications, Wiley
7. Rohatgi, V. K. and Saleh, A.K. Md. E. (2001): Introduction to Probability and Statistics, John Wiley & Sons, New York.

SEMESTER-VIII

COURSE 21 A: ADVANCED OPTIMIZATION TECHNIQUES

Theory Credits: 3 3 hrs/week

I. Syllabus

UNIT I

Simulation – Types of Simulation: Analogue simulation, Computer simulation Random Variable: Random Number, Pseudo-random numbers, Monte - Carlo Simulation, Generation of Random numbers, and Simple exercises.

UNIT II

Decision theory – Basic Terminology in Decision Theory, Steps in the decision-making process, Decision-Making Environment: Decision-making under conditions of Certainty, Decision-making under Uncertainty: Maximin gain criterion or Minimax loss function, Maximax gain criterion or Minimin loss criterion, Laplace criterion, Decision-making under conditions of Risk: Expected Money Value criterion, Expected Opportunity Loss criterion, Expected value of Perfect Information and simple exercises

UNIT III

Inventory Control 1 – Introduction, Reasons for maintenance Inventories, Types of Inventory, Inventory costs, Variables in the Inventory Problem, Other factors Involved in Inventory Analysis: Demand, Lead Time, Amount of Delivered, Order Cycle, Time Horizon, Recorder Level

UNIT IV

Inventory Control 2 – Deterministic Inventory Model: EOQ Models without Shortages, EOQ Models with Shortages, Inventory Models with Probabilistic Demand, Re-order Level and Optimum Buffer Stock and simple exercises

UNIT V

Goal Programming Problem (GPP): Introduction, Concept of GPP, Goal Programming as an extension of LPP, single goal models, multiple goals models, multiple goals with priorities, formulation of Goal Programming models, Graphical solution, extended simplex method applied to GPP.

II. References

1. S. D. Sharma(2012): Operations Research, Kadar Nath Ram Nath Publications.
2. Chong, E. K. P. and Zak, S. (2004). An Introduction to Optimization, Wiley.
3. Fletcher, R. (2000). Practical Methods of Optimization,Wiley.

SEMESTER-VIII

COURSE 21 A: ADVANCED OPTIMIZATION TECHNIQUES

Practical Credits: 1 2 hrs/week

1. Simulation application to queuing problem
2. Simulation application to capita building
3. Graphical solution of Goal Programming problems
4. Extended simplex method problem for Goal Programming
5. Problems on EOQ models
6. Intra block analysis of BIBD.
7. Intra block analysis of asymmetric BIBD.
8. Analysis of 2^2 and 2^3 factorial in CRD, RBD and LSD.
9. Analysis of 3^2 factorial in CRD and RBD.
10. Analysis of completely confounded two level factorial design in 2 blocks.
11. Analysis of completely confounded two level factorial design in 4 blocks.
12. Analysis of partially confounded two level factorial design.

SEMESTER-VIII

COURSE 21 B: ADVANCED ACTUARIAL STATISTICS

Theory Credits: 3 3 hrs/week

I. Syllabus

UNIT I

Future life time random variable, its distribution function and density function, concept of force of mortality, curate future life time random variable its probability mass function, deferred probabilities, all these functions in terms of international actuarial notation.

UNIT II

Analytical laws of mortality such as Gompertz law and Makeham's law, Single decreament life table, select and ultimate life table.

Concept of compound interest rate, discount factor, present value of the money, nominal rate of interest, force of interest, Assurance contracts with level and varying benefits, such as whole life insurance, term insurance endowment insurance.

UNIT III

Means and variances of the present value random variables of the payments under these contracts under the assumption of constant force of interest, when the benefit payments are made at the end of year of death (discrete set up) or when it is paid at the epoch of death(continuous set up). Actuarial present value of the benefit, Net single premiums.

UNIT IV

Annuity contracts, annuity certain, discrete annuity, monthly annuity, continuous annuity, deferred annuity, present values and accumulated values of these annuities. Continuous life annuity, discrete life annuity, such as whole life annuity, temporary life annuity, n-year certain and life annuity, life annuities with mthly payments, Present value random variables for these annuity payments, their means and variances, Actuarial present value of the annuity

UNIT V

Loss at issue random variable, various principles to decide net premiums for insurance products and annuity schemes defined in unit II and III, fully continuous premiums and fully discrete premiums, True monthly payment premiums. Extended equivalence principle to decide gross premiums, Concept of reserve, prospective & retrospective approach, Fully continuous reserve, Fully discrete reserve.

II. References

1. Deshmukh S.R. (2009). Actuarial Statistics: An Introduction Using R, Universities Press.
2. Harriett, E.J. and Dani, L. L.(1999). Principles of Insurance: Life, Health, and Annuities, 2nd Edn., Life Office Management Association.
3. Neill, Alistair (1977). Life Contingencies, The Institute of Actuaries.
4. Palande, P. S., Shah, R. S. and Lunawat, M. L. (2003). Insurance in India - Changing Policies and Emerging Opportunities, Response Books.

SEMESTER-VIII

COURSE 21B: ADVANCED ACTUARIAL STATISTICS

Practical Credits: 1 2 hrs/week

1. Computation of values of utility function.
2. Computation of various components of life tables.
3. Computation of compound interest (nominal and effective rate of interests).
4. Annuities and annuity dues.
5. Computation of premium for Term insurance and Whole life insurance.
6. Computation of premium for Endowment insurance.
7. Construction of multiple decrement table for deterministic survival group.
8. Determination of distribution function, survival function and force of mortality.
9. Fitting of Bivariate Normal distribution
10. Fitting of Cauchy distributions
11. Fitting of Gamma distribution with two parameters
12. Fitting of Lognormal Distribution
13. Fitting of Weibull Distribution
14. Fitting of Pareto distribution.

SEMESTER-VIII

COURSE 22 A: ADVANCED DESIGN AND ANALYSIS OF EXPERIMENTS

Theory Credits: 3 3 hrs/week

I. Syllabus

UNIT I

Linear Model: Estimability of linear parametric functions; BLUE, Gauss - Markoff theorem; Generalized Gauss - Markoff theorem, ANOVA model, ANOVA for Two way and three-way classifications

UNIT II

ANCOVA: Introduction, Uses, assumptions and analysis technique for one way and two-way classifications.

UNIT III

Necessity of confounding, Types of confounding, complete and partial confounding in 2^n, 3^2 and 3^3 factorial designs, Analysis of confounded factorial designs, Fractional Replication

UNIT IV

Split Plot design. Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties, Symmetric BIBD

UNIT V

Resolvable BIBD, Affine Resolvable BIBD, Intra Block analysis, complimentary BIBD, Residual BIBD, Dual BIBD, Derived BIBD.

II. References

1. M.N. Das and N.C. Giri (1979), Design and Analysis of Experiments, Wiley, Eastern, Pvt. Ltd. New Delhi.
2. C.D. Montgomery (1976), Design and Analysis of Experiments, Wiley & Sons, New York
3. M.C. Chakravarthy, (1962), Mathematics of Design of Experiments, Asia Publishing House, Calcutta.

SEMESTER-VIII

COURSE 22 A: ADVANCED DESIGN AND ANALYSIS OF EXPERIMENTS

Practical Credits: 1 2 hrs/week

1. Simulation application to queuing problem
2. Simulation application to capita building
3. Graphical solution of Goal Programming problems
4. Extended simplex method problem for Goal Programming
5. Problems on EOQ models
6. Intra block analysis of BIBD.
7. Intra block analysis of asymmetric BIBD.
8. Analysis of 2^2 and 2^3 factorial in CRD, RBD and LSD.
9. Analysis of 3^2 factorial in CRD and RBD.
10. Analysis of completely confounded two level factorial design in 2 blocks.
11. Analysis of completely confounded two level factorial design in 4 blocks.
12. Analysis of partially confounded two level factorial design.

SEMESTER-VIII

COURSE 22 B: LINEAR ALGEBRA

Theory Credits: 4 5 hrs/week

I. Syllabus

UNIT I

Theory of equations, statement of the fundamental theorem of algebra and its consequences. Relation between roots and coefficients or any polynomial equations. Solutions of cubic and biquadratic equations when some conditions on roots of equations are given. Evaluation of the symmetric polynomials and roots of cubic and biquadratic equations.

UNIT II

Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem.

UNIT III

Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involuntary and nilpotent matrices. Adjoint and inverse of a matrix and related properties.

UNIT IV

Determinants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, Circulant determinants and Vandermonde determinants for nth order, Jacobi's Theorem, product of determinants. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.

UNIT V

Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse (concept with illustrations).Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, Linear orthogonal transformation and their digitalization.

II. References

1. Schaum's Outlines: Linear Algebra, Tata McGraw-Hill Edition, 3rdEdition, 2006.
2. Krishnamurthy V., Mainra V.P. and Arora J.L: An Introduction to Linear Algebra (II, III, IV, V).
3. Jain P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi,1973
4. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International.
5. Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.

SEMESTER-VIII

COURSE 23 A: MODERN INFERENTIAL STATISTICS

Theory Credits: 4 5 hrs/week

I. Syllabus

UNIT I

Fundamental notions of hypothesis testing–Statistical hypothesis, statistical test, Critical region, types of errors, test function, randomised and non–randomised tests, level of significance, power function, Most powerful test, Neyman–Pearson fundamental lemma and its applications, Uniformly most powerful tests for one parameter exponential families.

UNIT II

Monotone Likelihood Ratio property, likelihood ratio test, statement of the asymptotic properties of LR statistics with applications, LR test for the mean of normal population, LR test for equality of means of two normal populations, LR test for the equality of means of several normal populations or Bartlett's test statistic.

UNIT III

Concept of sequential estimation, sequential estimation of a normal population. Notions of sequential versus fixed sample size techniques. Wald's sequential probability Ratio test (SPRT) procedure for testing simple null hypothesis against simple alternative. Termination property of SPRT. SPRT procedures for Binomial, Poisson, Normal and Exponential distributions and associate OC and ASN functions. Statement of optimality of SPRT.

UNIT IV

Non parametric tests: Power efficiency, measurement – Nominal, Ordinal, Interval, Ratio Scales. Concept of U statistic with examples. Asymptotic normality of U statistic (statement only). Wilcoxon signed rank test for one sample problem, Kolmogorov – Smirnov test for one sample problem.

UNIT V

Two sample problems based on Wilcoxon signed rank test for paired comparisons, Wilcoxon – Mann – Whitney test, Kolmogorov – Smirnov test, Normal Scores test, Ansary – Bradley test, Kruskal – Wall's test for one way layout problems (k samples), Friedman test for two way layout problem, test of independence based on Spearman's and Kendall' statistics.

II. References

1. Rohatgi, V. K.: An Introduction to probability theory and Mathematical Statistics (Wiley Eastern)
2. Wald, A : Sequential Analysis, Dover Publications
3. Rao, C.R. : Linear Statistical Inference and its applications, John Wiley
4. Gibbons: Non-parametric Statistical Inference (1978)
5. Myles Hollander and Douglas A.W.: Non parametric statistical methods (John Wiley &Sons)
6. Parimal Mukhopadhyay: Mathematical Statistics

SEMESTER-VIII

COURSE 23 B: APPLIED PROBABILITY AND DISTRIBUTIONS

Theory Credits: 3 3 hrs/week

I. Syllabus

UNIT I

Normal, Lognormal, Weibull, Pareto and Cauchy distributions and their properties. Joint, Marginal and conditional pmf's and pdf's.

UNIT –II

Families of Distributions: Power series distributions, Exponential families of distributions. Functions of Random variables and their distributions (including transformation of rv's). Bivariate Normal, Bivariate Exponential (Marshall and Olkinsform).

UNIT III

Compound Binomial - Poisson, Gamma (α,β). Truncated (Binomial, Poisson, Normal and Lognormal) and mixture distributions – Definition and examples.

UNIT –IV

Sampling Distributions of sample mean and variance, independence of $\bar{X}$ and S^2. Central and Non-central χ^2, t and F distributions.

UNIT –V

Distributions of quadratic forms under normality and related distribution theory. Order statistics, their distributions and properties. Joint and marginal distributions of order statistics and Distribution of Range. Extreme values and their asymptotic distributions (statements only) with applications.

II. References

1. Rohatgi, V.K.(1984): An introduction to probability theory and mathematical Statistics, Wiley Eastern.
2. Rao, C.R.(1972): Linear Statistical Inference and its applications, 2/e, Wiley Eastern
3. Johnson,S. and Kotz,(1972): Distributions in Statistics, Vol.I, II and III, Houghton and Miffin.

SEMESTER-VIII

COURSE 23 B: APPLIED PROBABILITY AND DISTRIBUTIONS

Practical Credits: 1 2 hrs/week

15. Computation of values of utility function.
16. Computation of various components of life tables.
17. Computation of compound interest (nominal and effective rate of interests).
18. Annuities and annuity dues.
19. Computation of premium for Term insurance and Whole life insurance.
20. Computation of premium for Endowment insurance.
21. Construction of multiple decrement table for deterministic survival group.
22. Determination of distribution function, survival function and force of mortality.
23. Fitting of Bivariate Normal distribution
24. Fitting of Cauchy distributions
25. Fitting of Gamma distribution with two parameters
26. Fitting of Lognormal Distribution
27. Fitting of Weibull Distribution
28. Fitting of Pareto distribution.

SEMESTER-VIII

COURSE 24 A: STATISTICAL TECHNIQUES FOR RESEARCH METHODOLOGY

Theory Credits: 3 3 hrs/week

I. Syllabus

UNIT I

Introduction: Meaning, objection and motivation in research, types of research, research approach, significance of research. Research problems: definition, selection and necessity of research problems.

UNIT II

Survey Methodology and Data Collection, inference and error in surveys, the target populations, sampling frames and coverage error, methods of data collection, non-response, questions and answers in surveys.

UNIT III

Processing, Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.

UNIT IV

Develop a questionnaire, collect survey data pertaining to a research problem (such as gender discriminations in private v/s government sector, unemployment rates, removal of subsidy, impact on service class v/s unorganized sectors), interpret the results and draw inferences.

UNIT V

Formats of Reports: introduction, parts of a report, cover and title page, introductory pages, text, reference section, typing instructions, copy reading, proof reading. Presentation of a report: introduction, communication dimensions, presentation package, audio-visual aids, presenter's poise.

II. References

1. Kothari, C.R. (2009): Research Methodology: Methods and Techniques, 2nd Revised Edition reprint, New Age International Publishers.
2. Kumar, R (2011): Research Methodology: A Step - by - Step Guide for Beginners, SAGE publications.

SEMESTER-VIII

Set-1

COURSE 24 A: STATISTICAL TECHNIQUES FOR RESEARCH METHODOLOGY

Practical Credits: 1 2 hrs/week

PROJECT WORK

Submit a Project Report based on empirical study on some real life situation. It should be an original one and an indicative format for preparation is presented below:

Project report should be presented in the following sequence: i) Title page; ii)Student's declaration; iii) Supervisor's certificate; iv) Acknowledgements; v) Table of contents; vi)Abstract; vii) Literature Review; viii) Methodology; ix) Contents; x) major findings; xi) visualisations; xii) summary; xiii) Bibliography.

The student shall personally collect, analyse, interpret the data and prepare a report under the supervision of a faculty.

SEMESTER-VIII

COURSE 24 B: BIOSTATISTICS AND SURVIVAL ANALYSIS

Theory Credits: 4 5 hrs/week

I. Syllabus

UNITI

Survival Analysis: Functions of survival times, survival distributions and their applications-exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shaped hazard function. Censoring Schemes: TypeI, TypeII and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for Type I and Type II censored data with numerical examples.

UNIT II

Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator. Competing Risk Theory: Indices for measurement of probability of death under competing risks and their inter-relations.

UNIT III

Estimation of probabilities of death using maximum likelihood principle and modified minimum Chi-square methods. Theory of independent and dependent risks. Bivariate Normal Independent Risk Model.

UNIT IV

Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition. and concept(without derivation). Duration Of An Epidemic. Statistical Genetics: Introduction, concepts-Genotype, Phenotype, Dominance, Recessiveness, Linkage and Recombination, Coupling and Repulsion. Mendelian laws of Heredity, Random mating, Gametic Array relation between genotypic array and gametic array under random mating. Distribution of genotypes under random mating.

UNIT V

Clinical Trials: Planning and design of clinical trials, Phase I, II,III and IV trials. Clinical Blinding: Unblinded or Open label, Single blind or single masked, Double blind or double masked, Triple blind.

II. References

1. Biswas, S.(2007). Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, Reprinted 2nd Ed., New Central Book Agency.
2. Elandt-Johnson R.C(1971). Probability model and Statistical Methods in Genetics, John Wiley& Sons.
3. Indrayan, A.(2008): Medical Biostatistics, 2nd Ed., Chapman and Hall/CRC.
4. Lee, E.T. and Wang, J.W.(2003). Statistical Methods for Survival data Analysis, 3rd Ed., John Wiley & Sons.
5. Narayan P. (1999). Statistical Genetics, New Age International Pvt. Ltd.
6. Miller, R.G.(2011). Survival Analysis. John Wiley & Sons.

SEMESTER-VIII

COURSE 25 A: ECONOMETRICS

Theory Credits: 4 5 hrs/week

I. Syllabus

UNIT I

Basic Econometrics: Nature of econometrics and economic data, concept of econometrics, steps in empirical economic analysis, econometric model, importance of measurement in economics, the structure of econometric data, cross section, pooled cross section, time series and paired data.

UNIT II

Models and Estimations: simple regression models - two variable linear regression model, assumptions and estimation of parameters, Gauss Markoff theorem, OLS estimations, partial and multiple correlation coefficients. The general linear model assumptions, estimation and properties of estimators, BLUEs.

UNIT III

Heteroscedasticity: tests of significance of estimators, R square and ANOVA, concepts and consequences of heteroscedasticity, tests and solutions of heteroscedasticity, specification error, errors of measurement.

UNIT IV

Multicollinearity: concept of multicollinearity and its consequences on econometric models, detection of multicollinearity, measure of multicollinearity – variance Inflation factor (VIF) and tolerance, formula and interpretation, methods of reducing the influence of multicollinearity.

UNIT V

Auto Correlation: Disturbance Term In Economic Models And Its Assumptions, Consequences Of Autocorrelated Disturbances, Detecting The Presence Of Autocorrelations – Hypothesis Tests For Autocorrelation, Durbin – Watson Test – Estimation Of Autocorrelation Coefficient (For A First Order Autoregressive Scheme).

II. References

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
2. Johnston: Econometrics Methods (2nd Edition):
3. G.S. Maddala: Econometrics
4. A. Koutsoyiennis : Theory of econometrics

SEMESTER-VIII
COURSE 25 B: DATA MINING TECHNIQUES

Theory Credits: 3 3 hrs/week

I. Syllabus

Unit I
Data mining - KDD Vs Data Mining, Stages of the Data Mining Process-Task Primitives, Data Mining Techniques – Data Mining Knowledge Representation. Major Issues in Data Mining – Measurement and Data – Data Preprocessing – Data Cleaning - Data transformation- Feature Selection - Dimensionality reduction

Unit II: Predictive Analytics
Classification and Prediction - Basic Concepts of Classification and Prediction, General Approach to solving a classification problem- Logistic Regression - LDA - Decision Trees: Tree Construction Principle – Feature Selection measure – Tree Pruning - Decision Tree construction Algorithm, Random Forest, Bayesian Classification-Accuracy and Error Measures- Evaluating the Accuracy of the classifier / predictor- Ensemble methods and Model selection.

Unit III: Classification and Descriptive Analytics
Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction. Descriptive Analytics - Mining Frequent Itemsets - Market based model – Association and Sequential Rule Mining

Unit IV: Cluster Analysis
Basic concepts and Methods – Cluster Analysis – Partitioning methods – Hierarchical methods – Density Based Methods – Grid Based Methods – Evaluation of Clustering – Advanced Cluster Analysis: Probabilistic model based clustering – Clustering High – Dimensional Data – Clustering Graph and Network Data – Clustering with Constraints- Outlier Analysis.

Unit V: Factor Analysis
Meaning, objectives and Assumptions, Designing a factor analysis, Deriving factors and assessing overall factors, Interpreting the factors and validation of factor analysis.

II. References

1. Adelchi Azzalini, Bruno Scapa, “Data Analysis and Data mining” , 2nd Ediiton, Oxford Univeristy Press Inc., 2012.
2. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques”, 3rd Edition, Morgan Kaufmann Publishers, 2011.
3. Alex Berson and Stephen J. Smith, “Data Warehousing, Data Mining & OLAP”, 10th Edition, TataMc Graw Hill Edition , 2007.
4. G.K. Gupta, “Introduction to Data Mining with Case Studies”, 1st Edition, Easter Economy Edition, PHI, 2006.
5. Joseph F Hair, William C Black etal, “Multivariate Data Analysis”, Pearson Education, 7 th edition, 2013.

SEMESTER-VIII

COURSE 25 B: DATA MINING TECHNIQUES

Practical Credits: 1 2 hrs/week

Data Mining – Getting to know the Data (Using ORANGE WEKA or R Programming)

1. Parametric – Means, T-Test, Correlation
2. Prediction for numerical outcomes – Linear regression, Multiple Linear Regression
3. Correlation analysis
4. Implement clustering algorithm
5. Implement Association Rule mining
   a) Logistic Regression
   b) Naive Bayes
   c) Support Vector Machines