CBCS Syllabus as per NEP 2020 for S.Y.B.Com.
(2023 Pattern)

Name of the Programme	**:** B.Com.
Program Code	**:** UCOM
Class	**:** S.Y.B.Com
Semester	**:** IV
Course Type	**:** Minor Theory
Course Code	**:** COM-261-MN(D)
Course Title	**:** Applied Statistics-II
No. of Credits	**:** 4 credits
No. of Teaching Hours	**:** 60

Course Objectives:

1. To provide students with a solid foundation in real functions, derivatives, and their applications, particularly in the context of economics and commerce.
2. To equip students with the skills to model and solve transportation and assignment problems using various methods.
3. Learn to formulate Assignment Problems and apply solution algorithms such as the Hungarian Method for finding optimal assignments.
4. To introduce students to the key components of time series data and the methods for estimating trends, including the application of autoregressive models.
5. To familiarize students with the construction and interpretation of life tables, understanding the significance of life table functions and the expectation of life.
6. To introduce the concept and purpose of simulation, focusing on different types of simulation and their applications across various fields.
7. To teach students techniques for generating random numbers and variates, which are foundational in simulation and modelling exercises.
8. To explore the principles and applications of the Monte Carlo method, enabling students to perform simulations and understand their implications in real-world scenarios.

Course Outcomes:

Student will be able to

CO 1. Students will be able to analyse real functions and compute derivatives, applying these concepts to solve problems in economics and commerce.

CO 2. Students will demonstrate proficiency in formulating and solving transportation problems using different methods, leading to optimal solutions in logistics and operations.

CO 3. Students will gain the ability to solve assignment problems, understanding the relationship between assignment and transportation problems.

CO 4. Students will be capable of analysing time series data, estimating trends, and applying autoregressive models to real-world data, leading to informed decision-making in business and economics.

CO 5. Students will be able to construct and interpret life tables, understanding key life table functions and their applications in actuarial science and public health.

CO 6. Students will understand and apply simulation techniques, including deterministic and stochastic models, and will be able to generate random variables and variates for use in simulations.

CO 7. Students will be proficient in conducting Monte Carlo simulations, using them to solve problems in fields.

Topics and Learning Points:

UNIT-1 Functions, Derivatives and their applications (10L)

1.1. Concept of real Functions: constant function, linear function, x^2, e^x, a^x, logx, Demand, Supply, Total Revenue, Average Revenue, Total Cost, Average Cost and profit Function.

1.2. Equilibrium Point, Derivative as rate measure

1.3. Derivatives of Functions: Constant function, x^2, e^x, a^x, logx, etc.

1.4. Rules of derivatives: Scalar Multiplication, Sum, Difference, Product, Quotient, Simple Problems.

1.5. Second Order Derivatives

1.6. Applications: Marginal Cost, Marginal Revenue, Elasticity of Demand, Maxima and Minima for functions in Economics and Commerce.

UNIT-2 Transportation Problem (14L)

2.1. Transportation problem (T.P.), statement of T.P.

2.2. Obtaining basic feasible solution of T.P. by

(i) North-West Corner Method,

(ii) Least Cost Method

(iii) Vogel's Approximation Method (VAM).

2.3. Optimal solution using MODI method.

2.4. Examples and problems.

UNIT-3 Assignment Problem **(07L)**

3.1 Statement of an Assignment Problem, Minimization and Maximization problem.

3.2 Balanced and Unbalanced Assignment Problem.

3.3 Relation with Transportation Problem.

3.4 Optimal solution using Hungarian method, Minimization and Maximization case.

3.5 Examples and problems.

UNIT 4 : Time Series **(14L)**

4.1 Introduction, Meaning and utility of time series, Definition, Components of Time Series: i) The Trend ii) Seasonal variation iii) Cyclical variation iv) Irregular variation, Additive and Multiplicative Model

4.2 Methods of trend estimation and smoothing: (i) moving average, (ii) curve fitting by least square principle, (iii) exponential smoothing.

4.3 Choosing parameters for smoothing and forecasting.

4.4 Forecasting based on exponential smoothing.

4.5 Measurement of seasonal variations: i) simple average method, ii) ratio to moving average method, iii) ratio to trend where trend is calculated by method of least squares. **(For practical only)**

4.6 Fitting of autoregressive model $AR\,(1)$

4.7 Case studies of real-life Time Series: Price index series, share price index series, economic time series: temperature and rainfall time series, wind speed time series, pollution levels.

UNIT 5 : Life Table **(6 L)**

5.1 Introduction, Construction of life table, functions (l_x, d_x, p_x, q_x, L_x, T_x, e_x) and their interpretation, expectation of life.

5.2 Example, and problems.

UNIT 6 : Simulation **(9 L)**

6.1 Definition and purpose of simulation.

6.2 Types of simulation: Deterministic vs. Stochastic, Discrete vs. Continuous.

6.3 Applications of simulation in various fields (e.g., finance, engineering, healthcare).

6.4 Concept of random variables in simulation.

6.5 Methods for generating random variates: Inverse Transform

6.6 Monte Carlo Method: Introduction to the Monte Carlo method and its historical background, Basic principles: Random sampling, statistical estimation, and law of large numbers, Steps in performing a Monte Carlo simulation, Applications of the Monte Carlo method

References:

1. Gass, S. L. (1997). Linear programming methods and applications, Narosa Publishing House, New Delhi.
2. Gupta, P. K. and Hira, D. S. (2008). Operation Research, 3rd edition S. Chand and company Ltd, New Delhi.
3. Kapoor, V. K. (2006). Operations Research, S. Chand and Sons. New Delhi.
4. Phillips, D. T. and Solberg, R. A. (1976). Operation Research principles and practice, John Willey and Sons Inc.
5. Saceini, M., Yaspan, A. and Friedman, L. (2013). Operation Research methods and problems,Willey International Edition.
6. Brockwell, P. J., & Davis, R. A. (2016). Introduction to Time Series and Forecasting. Springer
7. Deshmukh S.R. (2009). Actuarial Statistics: An Introduction Using R, Universities Press.
8. Gupta S. C. &Kapoor V. K.: Fundamentals of Mathematical Statistics. (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi, 110002.

COs-POs Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	3	2	2	2	3	1	1	1	1	1	1	1	2	1	1
CO2	2	3	2	2	3	2	1	1	1	1	1	2	2	2	1
CO3	2	3	2	2	3	1	1	1	1	1	1	2	2	2	1
CO4	2	2	3	2	3	1	1	1	1	1	1	2	2	1	1
CO5	2	2	2	2	2	1	1	1	1	1	1	2	2	1	1
CO6	1	2	2	2	2	3	1	1	1	1	1	2	2	1	1
CO7	1	2	2	2	2	3	1	1	1	1	1	2	2	1	1

Justification

PO1: A Fundamental Knowledge and Coherent Understanding

CO1: Analyzing functions and computing derivatives applies fundamental mathematical knowledge to economics and commerce, showing a strong link. **(3)**

CO2: Formulating and solving transportation problems involves fundamental knowledge in logistics and operations management. **(2)**

CO3: Solving assignment problems and understanding their relationship with transportation problems demonstrates fundamental knowledge in optimization. **(2)**

CO4: Analyzing time series data and applying autoregressive models involves fundamental statistical knowledge relevant to business and economics. **(2)**

CO5: Constructing and interpreting life tables requires fundamental actuarial and public health knowledge. **(2)**

CO6: Applying simulation techniques involves fundamental knowledge in statistical modeling. **(1)**

CO7: Conducting Monte Carlo simulations reflects fundamental knowledge in probabilistic and statistical techniques. **(1)**

PO2: Procedural Knowledge for Skill Enhancement

CO1: Applying derivatives and solving problems enhances procedural skills in mathematics. **(2)**

CO2: Solving transportation problems involves procedural knowledge in logistics optimization. **(3)**

CO3: Addressing assignment problems requires procedural skills in optimization and operations research. **(3)**

CO4: Time series analysis and autoregressive modeling involve procedural knowledge in statistical analysis. **(2)**

CO5: Constructing life tables involves procedural skills in actuarial science. **(2)**

CO6: Simulation techniques involve procedural knowledge in modeling and data generation. **(2)**

CO7: Monte Carlo simulations require procedural knowledge in probabilistic modeling. **(2)**

PO3: Critical Thinking and Problem-Solving Skills

CO1: Using derivatives to solve problems in economics and commerce demonstrates critical thinking and problem-solving skills. **(3)**

CO2: Solving transportation problems and finding optimal solutions requires critical thinking and problem-solving abilities. **(3)**

CO3: Understanding and solving assignment problems involves critical problem-solving skills. **(3)**

CO4: Analyzing time series data and applying autoregressive models requires advanced critical thinking and problem-solving skills. **(3)**

CO5: Constructing and interpreting life tables involves critical thinking in actuarial science and public health. **(2)**

CO6: Applying simulation techniques requires problem-solving skills in complex modeling scenarios. **(2)**

CO7: Conducting Monte Carlo simulations demonstrates critical problem-solving in probabilistic contexts. **(2)**

PO4: Communication Skills

CO1: Communicating results of derivative calculations and their applications improves technical communication skills. **(2)**

CO2: Presenting solutions to transportation problems involves clear communication of optimization methods. **(2)**

CO3: Explaining assignment problems and their relationship to transportation problems involves effective technical communication. **(2)**

CO4: Communicating findings from time series analysis involves explaining complex statistical results. **(2)**

CO5: Constructing and explaining life tables requires clear communication of actuarial concepts. **(2)**

CO6: Explaining simulation techniques and results involves effective communication of modeling methods. **(2)**

CO7: Communicating results from Monte Carlo simulations requires clear presentation of probabilistic findings. **(2)**

PO5: Analytical Reasoning Skills

CO1: Applying derivatives in problem-solving reflects strong analytical reasoning skills. **(3)**

CO2: Solving transportation problems demonstrates analytical reasoning in logistical and operational contexts. **(3)**

CO3: Understanding and solving assignment problems involves analytical skills in optimization. **(3)**

CO4: Analyzing time series data and applying autoregressive models showcases advanced analytical reasoning. **(3)**

CO5: Constructing and interpreting life tables requires analytical reasoning in actuarial science. **(2)**

CO6: Applying simulation techniques involves analytical skills in modeling and data analysis. **(2)**

CO7: Conducting Monte Carlo simulations demonstrates analytical reasoning in probabilistic modeling. **(2)**

PO6: Innovation, Employability, and Entrepreneurial Skills

CO1: Applying derivatives to solve real-world problems reflects innovative use of mathematical concepts. **(1)**

CO2: Solving transportation problems innovatively can enhance employability in logistics and operations roles. **(2)**

CO3: Addressing assignment problems contributes to employability and operational efficiency. **(2)**

CO4: Time series analysis and autoregressive modeling showcase innovative problem-solving in business contexts. **(1)**

CO5: Constructing and applying life tables reflect innovative applications in actuarial science and public health. **(1)**

CO6: Applying simulation techniques highlights skills relevant to modern problem-solving and innovation. **(2)**

CO7: Monte Carlo simulations are used in innovative problem-solving across various fields. **(2)**

PO7: Multidisciplinary Competence

CO1: Applying derivatives in economics and commerce shows integration of mathematical knowledge across disciplines. **(1)**

CO2: Solving transportation problems involves multidisciplinary knowledge in logistics and operations. **(1)**

CO3: Understanding assignment problems relates to operational and logistical disciplines. **(1)**

CO4: Analyzing time series data incorporates knowledge applicable in business and economics. **(1)**

CO5: Constructing life tables involves knowledge across actuarial science and public health. **(1)**

CO6: Simulation techniques have applications in various fields, reflecting multidisciplinary competence. **(1)**

CO7: Monte Carlo simulations are applicable across different domains, showcasing broad multidisciplinary skills. **(1)**

PO8: Value Inculcation through Community Engagement

CO1: The application of derivatives and functions in economic problems does not directly engage with community values. **(1)**

CO2: Solving transportation problems can impact community logistics and operational efficiency indirectly. **(1)**

CO3: Addressing assignment problems can influence operational improvements that benefit communities. **(1)**

CO4: Time series analysis can support community-based economic decision-making. **(1)**

CO5: Constructing life tables impacts public health planning, benefiting communities. **(2)**

CO6: Simulation techniques can be applied to community-focused modeling and forecasting. **(1)**

CO7: Monte Carlo simulations can be used to solve community-related problems. **(1)**

PO9: Traditional Knowledge into Modern Application

CO1: Applying mathematical functions and derivatives reflects the integration of traditional mathematical knowledge into modern contexts. **(2)**

CO2: Formulating solutions for transportation problems shows the application of traditional operational research methods. **(2)**

CO3: Solving assignment problems incorporates traditional optimization methods in modern practices. **(2)**

CO4: Time series analysis utilizes traditional statistical methods adapted to contemporary data contexts. **(2)**

CO5: Life tables involve traditional actuarial methods applied to current public health contexts. **(2)**

CO6: Simulation techniques build on traditional statistical methods for modern applications. **(2)**

CO7: Monte Carlo simulations apply traditional probabilistic techniques to modern problem-solving. **(2)**

PO10: Design and Development of System

CO1: Derivative applications in problem-solving support the design of algorithms and systems. **(1)**

CO2: Solving transportation problems contributes to designing efficient logistical systems. **(2)**

CO3: Addressing assignment problems helps in designing operational and logistical systems. **(2)**

CO4: Time series analysis supports designing forecasting systems for business and economics. **(2)**

CO5: Life tables are used in designing actuarial and public health systems. **(2)**

CO6: Simulation techniques are integral to developing various modeling and system design applications. **(2)**

CO7: Monte Carlo simulations contribute to designing and developing complex systems. **(2)**

PO11: Ethical and Social Responsibility

CO1: Applying derivatives and mathematical functions does not directly engage with ethical and social responsibility. **(1)**

CO2: Solving transportation problems ethically involves responsible logistics and operations management. **(1)**

CO3: Addressing assignment problems involves ethical considerations in optimization and resource allocation. **(1)**

CO4: Analyzing time series data and applying autoregressive models involve responsible data use. **(1)**

CO5: Constructing life tables impacts public health and actuarial science with ethical considerations. **(2)**

CO6: Applying simulation techniques ethically involves responsible use of modeling and forecasting. **(1)**

CO7: Conducting Monte Carlo simulations requires ethical considerations in probabilistic modeling. **(1)**

PO12: Research-Related Skills

CO1: Analyzing functions and computing derivatives reflects research skills in mathematical and economic contexts. **(1)**

CO2: Solving transportation problems involves research skills in operational logistics. **(2)**

CO3: Solving assignment problems demonstrates research-related skills in optimization. **(2)**

CO4: Analyzing time series data and applying autoregressive models requires research skills in data analysis. **(2)**

CO5: Constructing and interpreting life tables involves research skills in actuarial science. **(2)**

CO6: Applying simulation techniques requires research skills in statistical modeling. **(2)**

CO7: Conducting Monte Carlo simulations involves advanced research skills in probabilistic techniques. **(2)**

PO13: Teamwork

CO1: Analyzing derivatives and functions is an individual task; teamwork is less emphasized. **(1)**

CO2: Solving transportation problems can involve teamwork in logistics and operations contexts. **(1)**

CO3: Addressing assignment problems may involve collaborative efforts in problem-solving. **(1)**

CO4: Time series analysis and autoregressive modeling can be part of a team-based project in business and economics. **(1)**

CO5: Constructing life tables can be a collaborative task in actuarial science and public health. **(1)**

CO6: Applying simulation techniques may involve teamwork in modeling and analysis projects. **(1)**

CO7: Conducting Monte Carlo simulations can be part of a team effort in complex problem-solving. **(1)**

PO14: Area Specific Expertise

CO1: Analyzing functions and derivatives applies mathematical expertise relevant to economics and commerce. **(1)**

CO2: Solving transportation problems involves area-specific expertise in logistics and operations. **(2)**

CO3: Addressing assignment problems demonstrates expertise in optimization within logistics and operations. **(2)**

CO4: Analyzing time series data requires expertise in statistical analysis relevant to business and economics. **(2)**

CO5: Constructing and interpreting life tables involves expertise in actuarial science and public health. **(2)**

CO6: Applying simulation techniques requires expertise in statistical and data modeling. **(2)**

CO7: Conducting Monte Carlo simulations showcases expertise in probabilistic and statistical techniques. **(2)**

PO15: Environmental Awareness

CO1: The application of derivatives and functions does not directly relate to environmental awareness. **(1)**

CO2: Solving transportation problems can impact environmental logistics and operational efficiency. **(1)**

CO3: Addressing assignment problems may have indirect environmental implications in resource allocation. **(1)**

CO4: Time series analysis can contribute to environmental data analysis and forecasting. **(1)**

CO5: Constructing life tables impacts public health and environmental planning. **(1)**

CO6: Simulation techniques can model environmental impacts and forecasts. **(1)**

CO7: Monte Carlo simulations can be used for environmental modeling and risk assessment. **(1)**