Appendix-16
Resolution No. 4-1-2

Minor Revision in 1st Year of M.Sc. (Computer Science)

1. **Minor Changes in Syllabus of DSC103: Mathematical Foundations of Computer Science**
2. **Addition of DSE 208: Research Methodology**

DSC103: Mathematical Foundations of Computer Science

Existing	Proposed
Course Objectives: This course will discuss fundamental concepts and tools in discrete mathematics with emphasis on their applications to computer science. The objectives of this course comprise providing students with knowledge of logic and Boolean circuits, sets, functions, relations, deterministic and randomised algorithms. Furthermore, the students will learn analysis techniques based on counting methods, recurrence relations, trees and graphs.	**Course Objective:** The objective of this course is to equip students with the selected fundamental concepts in mathematics and statistics that are commonly applied to solve computational problems. The students will learn exploratory data analysis techniques, visualization and basic data science techniques. NLP and Computer Vision applications of basic linear algebra concepts will be covered.
Course Learning Outcomes	**No Change**
Unit-I (8 Hours) **Vectors:** Definition of Vectors, Vector Addition, Dot and Cross Products, Span, Norm of vectors, Orthogonality, geometry of vectors, Application of vectors in document analysis.	**Unit-I (8 Hours)Vectors and Vector Spaces:** Definition of Vectors, Vector Addition, Dot and Cross Products, Span, Norm of vectors, Orthogonality, geometry of vectors; Projection of vector; Vector space, Subspace, Linear Combination, Linear Independence and Dependence, Basis and Dimensions, Convex set
Unit-II (12 Hours) **Matrix Algebra:** Matrix Algebra: Matrices as vectors; Matrix-vector, vector-matrix and matrix-matrix multiplications; Inner and outer products, triangular matrix, diagonal matrix, systems of linear equations, linear independence, determinant, rank of matrix, Eigen values and Eigen vectors, matrix transformations, geometry of transformations, Applications of matrix algebra in image representation and	**Unit-II (15 Hours)** **Matrix Algebra:** Matrices as vectors; Matrix-vector, vector-matrix and matrix-matrix multiplications; Inner and outer products, triangular matrix, diagonal matrix, determinant, rank of matrix, systems of linear equations, LU decomposition, Eigen values and Eigen vectors, matrix transformations, geometry of transformations, PCA, SVD, Applications of

transformations.	matrix algebra in Data Reduction, NLP, Face recognition, .
Unit-III (11 Hours) Probability Theory and Basic Statistics: Sample Space and Events, Probability axioms, Conditional Probability, Bayes' law, Introduction to Descriptive and Inferential Statistics, Describing Data Sets as Frequency tables, Relative frequency tables and graphs, Scatter diagram, Grouped data, Histograms, Ogives; Percentiles, Box Plot, Coefficient of variation, Skewness, Kurtosis.	**Unit-III (8 Hours)** Probability Theory and Basic Statistics: Sample Space and Events, Probability axioms, Conditional Probability, Bayes' Theorem, Joint and Marginal probability, Introduction to Descriptive and Inferential Statistics, Describing Data Sets as Frequency tables, Relative frequency tables and graphs, Scatter diagram, Grouped data, Histograms, Ogives; Percentiles, Box Plot, Coefficient of variation, Skewness, Kurtosis.
Unit-IV (14 Hours) Distributions: Continuous and Discrete random variables, probability density function, probability mass function, distribution function and their properties, mathematical expectation, conditional expectation, Uniform (continuous and discrete), Binomial, Poisson, Exponential, Normal, $\chi 2$ distributions, weak Law of Large Numbers, Central Limit Theorem, Chebyshev's inequality. Stochastic Processes Introduction to stochastic process, Markov Chain, Transition probabilities, Birth-Death process	**Unit-IV (14 Hours) Random Variables and Distributions:** Introduction to random variable, Discrete and Continuous random variables, probability density function, probability mass function, distribution function and their properties, Expectation, Variance, Conditional expectation, Moments, Discrete distributions (Bernoulli, Binomial, Multinomial, Poisson, Geometric), Continuous distributions(Uniform, Exponential, Normal, , $\chi 2$), Markov and Chebyshev's inequality, weak Law of Large Numbers, Central Limit Theorem, Stochastic Processes: Introduction to stochastic process, Markov Chain, Transition probabilities, Birth-Death process
Readings and Practicals	No Change

DSE208: Research Methodology

Course Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE208	4	3	0	1	Graduation	NIL

Course Objective

This course aims to impart the necessary skills to conduct research in computer science, enabling students to understand the research process, from problem identification to publication. The course also introduces students to research ethics.

Course Learning Outcomes

On the successful completion of the course, the student would be able to:

- identify the problem after conducting a literature survey using AI-supported tools.
- define goals, approach, and scope of the research and design the research methodology.
- effectively record and present study findings in a research paper format and prepare for publication.

Syllabus

Unit I **(13 Hours)**

Research Fundamentals: Meaning and significance of research, Characteristics of research, Types of research and research methods, Research process, Qualities of a good researcher, Choosing an appropriate problem area, Identifying sources of research articles, Research repositories and AI-based tools for literature survey, Metrics for research papers, Identifying research gaps, Formulating research questions, Research design.

Unit II **(15 Hours)**

Analysing Data and Experimental Results: Exploring and organising data sets, pre-processing data, and performing Exploratory data analysis, Descriptive statistics, analysing experimental results, Statistical inference, Testing of hypotheses, Interpretation of results, Presentation of experimental results as plots and tables, identification of possible weaknesses of the study.

Unit III **(12 Hours)**

Research Writing and Publication: Structure of the research paper/research proposal, Venues for publication and Funding agencies, Conference and Journal rankings, Process of journal/conference submission and review, Peer review process - single, blind and double blind, Preparing reply to editor and revising manuscript, scientometric analysis - citation index and analysis, plagiarism, plagiarism checker.

Unit IV **(5 Hours)**

Research Ethics: Ethical issues in research, protection from harm, right to privacy, conflict of interest, honesty with professional colleagues, professional code of ethics, intellectual property rights, fraud and misconduct in science, COPE guidelines, Asilomar AI Principles, research for societal good.

Essential/recommended readings

1. Thomas, C. G. (2021). Research Methodology and Scientific Writing, 2nd Ed. Springer.
2. Leedy, P. D., & Ormrod, J. E. (2016). Practical Research: Planning and Design, 11th Ed. Pearson.

Additional References:

1. Ghezzi. C. *Being a Researcher: An Informatics Perspective.* Springer
2. Locharoenrat, K. (2018). *Research Methodologies for Beginners*. PAN Stanford Publication, 2018
3. https://www.unesco.org/en/articles/what-you-need-know-about-unescos-new-ai-competency-frameworks-students-and-teachers?hub=32618

Suggested Practical List

Capstone Project: Students must choose an area of interest for research, based on the curriculum (but not limited by it) covered in the program. They should identify a research problem to solve. During the semester the students must document the research journey in the form of a report, which will be evaluated at the end of the semester. The students are encouraged to write a research paper based on the report, under the guidance of the teacher. The practical class for research methodology course should be utilized to perform the following tasks in the research process.

1. Search the research papers related to the chosen problem using academic search engines like Google Scholar, Scopus search, Web of Science database, etc.
    1. Evaluate the venue of the source of research paper - Journals using citation metrics like CiteScore, SCImago Journal Rank (SJR)), Source Normalized Impact per Paper (SNIP) etc., Conference venues are evaluated using indexing information, Core Ranking etc.
    2. Summarize the reviewed papers in a tabular format with columns: Paper Title, Author(s), Year, Key Findings, and Citation Count.
    3. Explore reference management tools like Mendley / Zotero / EndNote to organize, store, and manage references. (6 hours)

2. Identify a research problem after identifying the research gaps in the literature surveyed in your area of interest. Formulate the research questions that you aim to address. Design methodology to solve the problem, evaluate the performance of the proposed method using appropriate data analysis techniques / statistical tests. Check if the research questions have been answered. If not, note the possible reasons for failure. (15 hours)

3. Write the research report and convert it to the research paper format, as per the chosen venue of publication. (9 hours)

    a) Choose a document writing software and prepare the report as per the format given by the teacher.
    b) Use the plagiarism check tool to assess the similarity index of the report and ensure that it is less than 10%.
    c) Explore the journal finder tools available for the publishers and select a suitable journal to submit the manuscript