## PhD Written Exam Syllabus

## Department of Artificial Intelligence and Data Engineering

**Probability & Statistics:** Counting, probability axioms, Bayes Theorem, expectation, variance, mean, median, mode, standard deviation, correlation, covariance, random variables (discrete: Bernoulli, binomial; continuous: normal, exponential, Poisson), distributions (t, chi-squared), cumulative PDF, central limit theorem, confidence intervals, z-test, t-test, chi-squared test.

**Linear Algebra, Calculus & Optimization:** Vector spaces, subspaces, linear (in)dependence, matrices (projection, orthogonal, idempotent, partition), quadratic forms, linear equations, Gaussian elimination, eigenvalues, eigenvectors, determinant, rank, nullity, LU decomposition, SVD, Single-variable functions, limits, continuity, differentiability, Taylor series, maxima, minima, single-variable optimization.

**Programming, Data Structures and Algorithms:** Programming in Python, basic data structures: stacks, queues, linked lists, trees, hash tables; Search algorithms: linear search and binary search, basic sorting algorithms: selection sort, bubble sort and insertion sort; divide and conquer: mergesort, quicksort; introduction to graph theory; basic graph algorithms: traversals and shortest path.

**Database Management and Warehousing:** ER-model, relational model (algebra, tuple calculus, SQL), integrity constraints, normalization, file organization, indexing, data types, data transformation (normalization, discretization, sampling, compression); data warehousing: multidimensional schemas, concept hierarchies, measures (categorization, computations).

## Machine Learning:

(i) Supervised Learning: Regression (simple, multiple, ridge, logistic), k-nearest neighbor, naive Bayes, linear discriminant analysis, support vector machine, decision trees, bias-variance trade-off, cross-validation (LOO, k-fold), multi-layer perceptron, feed-forward neural network.

(ii) Unsupervised Learning: Clustering (k-means, k-medoids, hierarchical: single/multiple linkage), dimensionality reduction (PCA).

iii) Data visualization, Exploratory Data Analysis (EDA), Data Wrangling

Artificial Intelligence: Search (informed, uninformed, adversarial), logic (propositional, predicate), reasoning under uncertainty (conditional independence, exact inference, variable elimination, approximate inference via sampling).