Course Description Form

1. Course Name:
Pattern Recognition
2. Course Code:
3. Semester / Year:
PhD– First Course– 2025–2026
4. Description Preparation Date:
15/10/2025
5. Available Attendance Forms:
Attendance Mandatory
6. Number of Credit Hours (Total) / Number of Units (Total)
30 Hours (2 Hours Theoretical)*15/ 2 Credit
7. Course administrator's name (mention all, if more than one name)
Name: Assistant Professor Dr. Khamael Al-Dulaimi Email :khamail.abbass@nahrainuniv.edu.iq

8. Course Objectives

Course Objectives	**Understand the fundamental concepts of pattern recognition**, including classification, clustering, and pattern analysis **Analyse data and extract meaningful features** for effective pattern representation. **Differentiate between parametric and non-parametric approaches**, as well as statistical and machine learning-based methods. **Apply common pattern recognition algorithms** such as k-Nearest Neighbours, Bayesian classifiers, and Support Vector Machines to real-world datasets. **Evaluate the performance of pattern recognition systems** using standard metrics such as accuracy, precision, and recall. **Understand the impact of feature selection, high dimensionality, and noise** on recognition performance. **Relate pattern recognition techniques to real-world applications**, including computer vision, image recognition, signal processing, and cybersecurity

9. Teaching and Learning Strategies

Strategy	**Research-Based Learning** Students critically review recent journal and conference papers, focusing on methodology, assumptions, limitations, and research gaps. **Advanced Scholarly Discussions** Seminars and discussions are used to compare and debate pattern recognition models and algorithms, fostering high-level analytical thinking. **Open-Ended Problem Solving** Students are challenged with open research problems that require proposing novel approaches or improving existing techniques rather than applying predefined solutions. **Integration of Theory and Research Practice** Students conduct experimental studies using real-world or benchmark datasets and analyse results in a publication-oriented manner

10. Course Structure

Week(s)	Hours	Intended Learning Outcomes	Module / Topic	Teaching Method	Assessment Method
1	2	Understand the concept of pattern recognition and its various applications	**Module 1: Foundations of Pattern Recognition** • Definitions and Scope • Applications in Computer Vision, NLP, Bioinformatics • Pattern Recognition System Architecture • Supervised vs Unsupervised vs Semi-supervised Learning	Lectures	In-class questions
2–4	2	Mathematical analysis of algorithms	**Module 2: Statistical Pattern Recognition** • Bayes Decision Theory • Maximum Likelihood Estimation (MLE) • Bayesian Estimation • Parametric vs Non-parametric Methods • Gaussian Mixture Models (GMM) • Expectation Maximisation (EM)	Lectures	Problem analysis and application of algorithms on real datasets
5–7	2	Mathematical analysis of algorithms and detailed	**Module 3: Feature Extraction and Selection** • Feature Space &	Lectures + Examples	Problem analysis and application of

		explanation of deriving numerical outputs for single and multivariate cases, and evaluating the quality of linear models	Dimensionality Reduction • PCA, LDA, ICA • Mutual Information & Entropy-Based Selection • Wrapper vs Filter Methods		algorithms on real datasets
8	2	—	**Midterm Exam 1**	—	Written exam
9	2	Understand how to obtain data outputs using classification algorithms	**Module 4: Classifiers and Decision Boundaries** • Linear Classifiers (Perceptron, LDA) • k-NN and Variants	Student Seminar	Method analysis, explanation, and application on data
10	2	Understand how to obtain data outputs using neural-based algorithms	**Module 5: Neural Approaches** • Multi-Layer Perceptron (MLP) • Convolutional Neural Networks (CNNs)	Student Seminar	Method analysis, explanation, and application on data
11	2	Understand how to obtain data outputs using clustering algorithms	**Module 6: Clustering and Unsupervised Learning** • k-Means • DBSCAN • Hierarchical Clustering	Student Seminar	Method analysis, explanation, and application on data
12	4	Understand how to obtain data outputs using ensemble techniques	**Ensemble Methods** • Bagging • Boosting	Student Seminar	Method analysis, explanation, and application on data
13	2	—	**Midterm Exam 2**	—	Written exam
14–15	4	Mathematical analysis of a selected problem, hypothesis formulation, and logical interpretation of results	**Selected Topics**	Discussion of results	Group project

11. Course Evaluation

Assessment Type	Marks
Quizzes	7
Projects	8
Mid Exam	10
Final Exam	50
Total	100

12. Learning and Teaching Resources

Required textbooks (curricular books, if any)	Textbooks and References - Duda, R. O., Hart, P. E., & Stork, D. G. (2001). Pattern Classification. Wiley-Inter science. Theodoridis, S., & Koutroumbas, K. (2009). Pattern Recognition (4th ed.). Academic Press. -
Main references (sources)	Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer. -
Recommended books and references (scientific journals, reports…)	Murphy, K. P. (2012). Machine Learni A Probabilistic Perspective. MIT Pres Jain, A. K., Duin, R. P. W., & Mao (2000). Statistical pattern recognition review. IEEE Transactions on Patt Analysis and Machine Intelligence, 22(4-37.
Electronic References, Websites	Research paper+ websites for dataset