# Course specification

## (2206 Pattern Recognition)

| | |
|---|---|
| *Faculty:* | HICIT- *Higher Institute for Computers & Information Technology-*El Shorouk Academy |
| **Programme(s) on which the course is given:** | Under graduate program in Computer Science |
| **Major or minor element of programme:** | Compulsory |
| **Department offering the programme** | Department of Computer Science |
| **Department offering the course:** | Department of Computer Science |
| **Year / Class** | 2$^{nd}$ Year – 2$^{nd}$ semester |
| **Date of specification approval** | 1/8/2022 |

## A- Basic Information

| *Title:* **Pattern Recognition** | | *Code:* **2206** | |
|---|---|---|---|
| **Weekly Hours:** | | | |
| **Lecture : 3** | **Exercise: -** | **Practical : 3** | **Total: 6** |

## B- Professional Information

### 1- Course Aims:

The objective of this course is to teach the Pattern Recognition methodologies.
After completing this course, the student should be able to:
   a. Understand the Pattern Recognition theory.
   b. Understand the PR techniques related to the analysis, design and implementation of the system that holds Patterns.
   c. Understand how to apply the PR concepts in building a real Pattern Recognition system.

### 2- Program ILOs Covered by Course

| *Program Intended Learning Outcomes* | | | |
|---|---|---|---|
| **Knowledge and understanding** | **Intellectual Skills** | **Professional and practical skills** | **General and Transferable skills** |
| **A6, A7, A12, A14, A21** | **B2, B3, B4** | **C10, C16** | **D5, D11** |

### 3- Intended learning outcomes of course (ILOs)
### a. Knowledge and Under-Standing:
**a1**. Define a wide range of principles and tools available to the PR principles,[A6, A7,A12, A21]]
**a2**. Identify the notion of Pattern Recognition systems, [A7]
**a3**. Identify the PR  in the software process.[A6,A13]
**a4**. Clarify and compare the linear classifiers, Clarify and compare the Nonlinear classifiers, Clarify  the notion of clustering, compare the various types of clustering algorithms.[A6,A7,A14]]

**b. Intellectual Skills:**

**b1**. Synthesis and evaluating the technical concepts of the syllabus.[B2,B3,B4]

**b2**. Appraisal of theory and its relevance to different situations, analysis of tasks into understandable and manageable subtasks.[B2]

**b3**. Synthesis of clearly and precisely stated solutions for problems.[B3,B4]

**b4**. Design the proposed systems for validity, correction, refinement and maintenance of the proposed systems.[B2,B3,B4]

**c- Professional and practical skills**

**c1**. Develop a qualitative and quantitative skills including data analysis, interpretation and extrapolation[C10]

**c2**. Implement computer prototype and real pattern recognition systems covering all the basic concepts in PR choosing a suitable language for the Implementation.[C16]

**d- General and transferable skills**

**d1**. Work in a group to Build a prototype and real PR systems using the general knowledge in the course, solving general computational problems[D11]

d2- Learn some Internet/Library searching strategies.[D5]

d3- write a short report using appropriate scientific language.[D5]

**4- Contents**

| Topic | Hours | Lec. | Exc/Lab |
|---|---|---|---|
| Introduction : Pattern Recognition Systems ( Sensing, Segmentation and Grouping, Feature Extraction, Classification, and Post Processing). the design cycle, learning and adaptation. | 8 | 4 | 4 |
| Bayesian Decision Theory: Bayes Decision Theory-Continues Features, Minimum-Error – Rate Classification. The Normal Density: Univariate Density, Multivariate Density.Marckov Chains. | 12 | 6 | 6 |
| Linear Classifiers: Linear Discriminant Functions and Decision Hyperplanes, the Perceptron Algorithm, Least Square Methods, Mean Square Estimation. | 12 | 6 | 6 |
| Nonlinear Classifiers: The two layer Perceptron, Three Layer Perceptrons, Algorithms Based on correct Classification of the Training Set, The Backpropagation Algorithm, Validations on the Backpropagation Theme, The Cost Function Choice. | 12 | 6 | 6 |
| Clustering : Basic Concepts, Proximity Measures. Sequential Clustering Algorithms: Basic Sequential Algorithmic Scheme, Modified Basic Sequential Algorithmic Scheme, and a Two-Threshold Sequential Algorithmic Scheme. | 12 | 6 | 6 |
| Hierarchical Clustering Algorithms: Agglomerative Algorithms, Agglomerative Algorithms Based on Matrix Theory. | 8 | 4 | 4 |
| Clustering via cost optimization : Stochastic Simulated Annealing, Deterministic Simulated Annealing. | 8 | 4 | 4 |
| Selected Topic | 6 | 3 | 3 |

## 5- Teaching and learning methods

| Teaching and learning methods | Used |
|---|:---:|
| **Active Learning** | |
| Lectures(blending learning – online learning using virtual classroom) | √ |
| Tutorial Exercises (hybrid learning – online learning) | √ |
| Practical Lab(blending learning– online learning) | √ |
| Exercises | √ |
| Discussions. | √ |
| **Self – Learning strategy** | |
| Reading material | √ |
| Websites search | √ |
| Research and reporting | √ |
| Self-studies | √ |
| **Experimental strategy** | |
| Group work | - |
| Presentation | √ |
| **Problem solving strategy** | |
| Problem solving/problem solving learning based | √ |
| Case study | - |
| **Synchronous E-Learning** | |
| Virtual lab | - |
| Virtual class | - |
| Chat Room | - |
| Video lectures | √ |
| **Asynchronous E-Learning** | |
| E-Learning | √ |

## 6- Student assessment methods

| Methods | Assessment | Used |
|---|---|:---:|
| Electronic Midterm Exam | To assess the knowledge and understanding achieved by the student during the previous weeks. (online on e-learning hub ) | √ |
| Pencil-to-Paper Final Exam | To evaluate what the student gain at the end of the course, and to assess: the knowledge and understanding, general skills, and intellectual skills. | √ |
| Electronic Course Work & Quizzes | To keep the student always in the course, and to evaluate knowledge, understanding, intellectual, and transferable skills.(online on e-learning hub) | √ |

| | | |
|---|---|---|
| Course Project | To allow students work in team, and to evaluate knowledge, understanding, intellectual, and transferable  skills. | √ |

**Assessment Schedule**

| Assessment | Week # |
|---|---|
| **Electronic Mid Term Exam** | **8** |
| **Final Exam** | **16** |
| **Course project** | **3-14** |
| **Electronic/ hard copy  Course Work &Quizzes** | **2-14** |

**Assessment Weight**

| Assessment | Weight % |
|---|---|
| **Electronic Mid Term Exam** | **5%** |
| **Final Exam** | **80%** |
| **Electronic/ hard copy Course Work &Quizzes** | **10%** |
| **Course project** | **5%** |
| **Total** | **100** |

– Course Work &Quizzes:
  o (Short Exams, Assignments, Researches, Reports, Presentations, Class/Project discussion)

# 6 -List of references

| • Essential books (text books) | - Pattern Recognition, S. Theodoridis, and K. Koutroumbas, 2006.<br>- Pattern Classification, Richard O. Duda, Peter E. Hart, and David G. Stork,2001.<br><br>-Duda, R. O. (2022, July 20). *Pattern Classification*.<br><br>-Homenda, W., & Pedrycz, W. (2018, February *Pattern Recognition: A Quality of Data Perspective*. |
|---|---|
| **Course notes** | – Pattern Recognition 4th Edition **by** Sergios Theodoridis Sergios Theodoridis Konstantinos Koutroumbas |
| **Recommended books** | – Pattern recognition and machine learning by Christopher M. Bishop |

| | | Pattern classification by Richard O. Duda, peter E.hart, David G. Stork |
|---|---|---|
| **Periodicals,website** | | **Powerpoint presentations of all course materials** <br> **All labs material** <br> **https://moodle.sha.edu.eg/course/view.php?id=2254** |

## 7- Required Facilities

To assess professional and practical skills given the following facilities:

a. Tools & SW  (Technologies facilities):

- Python
- **Microsoft TEAMS  to create virtual classrooms for lectures, discussions for project**
- **portal(MOODLE) to make electronic quizzes and electronic midterm exam**
- **portal(MOODLE) to upload project deliverable and assignment**
- **academy portal(MOODLE) to upload electronic material**
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b. Teaching facilities:

| | *Lecture* | *class* | *Lab* |
|---|---|---|---|
| Whiteboard | used | - | used |
| Pc/laptop | used | - | used |
| Data show | used | - | used |
| Webinars | MS TEAMS | - | MS TEAMS |
| ChatRoom | ChatTeams | - | ChatTeams |
| Videos | Stream-MOODLE | - | Stream-MOODLE |
| Website | MOODLE | - | MOODLE |

## 8- Course Matrices

### 8.1- Course Content/ILO Matrix

| Course Contents | Knowledge & understanding | | | | Intellectual skills | | | | Professional and practical skills | | General | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | b1 | b2 | b3 | b4 | c1 | c2 | d1 | d2 | d3 |
| Introduction : Pattern Recognition Systems ( Sensing, Segmentation and Grouping, Feature Extraction, Classification, and Post Processing). the design cycle, learning and adaptation. | x | x | x | | x | x | x | | x | | | | |
| Bayesian Decision Theory: Bayes Decision Theory- Continues Features, Minimum-Error – Rate Classification. The Normal Density: Univariate Density, Multivariate Density. Marckov Chains. | x | x | x | | x | x | x | | x | | | | |
| Linear Classifiers: Linear Discriminant Functions and Decision Hyperplanes, the Perceptron Algorithm, Least Square | x | x | x | x | x | x | x | x | x | | | | |

| Course Contents | Knowledge & understanding | | | | Intellectual skills | | | | Professional and practical skills | | General | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | b1 | b2 | b3 | b4 | c1 | c2 | d1 | d2 | d3 |
| Methods, Mean Square Estimation. | | | | | | | | | | | | | |
| Nonlinear Classifiers: The two layer Perceptron, Three Layer Perceptrons, Algorithms Based on correct Classification of the Training Set, The Backpropagation Algorithm, Validations on the Backpropagation Theme, The Cost Function Choice. | x | x | x | x | x | x | x | x | x | x | | | |
| Clustering : Basic Concepts, Proximity Measures. Sequential Clustering Algorithms: Basic Sequential Algorithmic Scheme, Modified Basic Sequential Algorithmic Scheme, and a Two-Threshold Sequential Algorithmic Scheme. | x | x | x | x | x | x | x | x | x | x | | | |
| Hierarchical Clustering Algorithms: Agglomerative Algorithms, Agglomerative Algorithms Based on Matrix Theory. | x | x | x | x | x | x | x | x | x | x | | | |
| Clustering via cost optimization : Stochastic Simulated Annealing, Deterministic Simulated Annealing. | x | x | x | x | x | x | x | x | x | x | | | |
| Clustering using Genetic Algorithms. | x | x | x | x | x | x | x | x | x | x | | | |
| Selected Topic | x | | | | | x | | | | | | | |
| Course project | x | x | x | x | x | x | x | x | x | x | x | x | x |

## 8.2- Learning Method /ILOs Matrix

| Learning Methods | Knowledge and understanding | | | | Intellectual skills | | | | Professional and practical skills | | General | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | b1 | b2 | b3 | b4 | c1 | c2 | d1 | d2 | d3 |
| Lecture | x | x | x | x | x | x | x | x | x | x | | | |
| Tutorial Exercises | | | | | x | x | x | x | x | x | | | |
| Practical Lab | | | | | x | x | x | x | x | x | | | |
| Discussion | | | | | x | x | x | x | x | x | x | x | x |
| Reading material | x | x | x | x | | | | | | | | | |
| Websites search | x | x | x | x | x | x | x | x | | | | | |
| Research and reporting | x | x | x | x | x | x | x | x | | | | | |
| Self-studies | x | x | x | x | | | | | | | | | |
| Problem solving/problem solving learning based | | | | | x | x | x | x | x | x | | | |

## 8.3 Assessment Methods /ILOs Matrix

| Assessment Methods | Knowledge & understanding | | | | Intellectual skills | | | | Professional & practical skills | | General | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | b1 | b2 | b3 | b4 | c1 | c2 | d1 | d2 | d3 |
| Electronic Mid Term Exam | x | x | x | x | x | x | x | x | x | x | | | |
| Final Exam | x | x | x | x | x | x | x | x | x | x | | | |
| Electronic Course Project | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Electronic Course Work &Quizzes | x | x | x | x | x | x | x | x | x | x | x | x | x |

## 9. Course ILOs Vs Program ILOs

| Course ILOs | Prog ILOs | Knowledge & understanding | | | | | | Intellectual skills | | | Professional and practical skills | | General | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A6 | A7 | A12 | A13 | A14 | A21 | B2 | B3 | B4 | C10 | C16 | D5 | D11 |
| K&U | a1 | √ | √ | √ | | | √ | | | | | | | |
| | a2 | | √ | | | | | | | | | | | |
| | a3 | √ | | | √ | | | | | | | | | |
| | a4 | √ | √ | | | √ | | | | | | | | |
| Int. | b1 | | | | | | | √ | √ | √ | | | | |
| | b2 | | | | | | | √ | | | | | | |
| | b3 | | | | | | | √ | √ | √ | | | | |
| | b4 | | | | | | | √ | √ | √ | | | | |
| P. &P. | c1 | | | | | | | | | | √ | | | |
| | c2 | | | | | | | | | | | √ | | |
| General | d1 | | | | | | | | | | | | | √ |
| | d2 | | | | | | | | | | | | √ | |

**Course Coordinator:** Prof. Dr. Negm Shawky    (                    )
**Head of Department:** Dr. Ahmed El-Abbassy  (                    )
**Date:** 1/8/2022