QF01/0408-4.0E	Course Plan for Bachelor program - Study Plan Development and Updating Procedures/ Artificial Intelligence Department

Study plan No.	**2021/2022**		**University Specialization**		**Artificial Intelligence**
Course No.	**0142232**		**Course name**		**Machine Learning**
Credit Hours	**3 hours**		**Prerequisite Co-requisite**		**Computing Systems for Data Science and Artificial Intelligence**
Course type	☐ MANDATORY UNIVERSITY REQUIREMENT	☐ UNIVERSITY ELECTIVE REQUIREMENTS	☐ FACULTY MANDATORY REQUIREMENT	☐ Support course family requirements	☐ √ Mandatory requirements / ☐ Elective requirements
Teaching style	☐ **Full online learning**		☐ **Blended learning**		☐ **√ Traditional learning**
Teaching model	☐ **2Synchronous: 1asynchronous**		☐ **2 face to face : 1synchronous**		☐ **√ 3 Traditional**

Faculty member and study divisions information (to be filled in each semester by the subject instructor)

Name	Academic rank	Office No.	Phone No.	E-mail	
Division number	**Time**	**Place**	**Number of students**	**Teaching style**	**Approved model**

Brief description

This course will introduce the field of Machine Learning, in particular focusing on the core concepts of supervised and unsupervised learning. In supervised learning, we will discuss algorithms which are trained on input data labelled with a desired output, for instance an image of a face and the name of the person whose face it is, and learn a function mapping from the input to the output. Unsupervised learning aims to discover latent structure in an input signal where no output labels are available, an example of which is grouping web-pages based on the topics they discuss.

Learning resources

Course book information (Title, author, date of issue, publisher ... etc)	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition. by. Aurélien Géron, 2019.			
Supportive learning resources (Books, databases, periodicals, software, applications, others)	1. Machine Learning with Python Cookbook Practical Solutions from Preprocessing to Deep Learning, by Chris Albon, 2018. 2. Foundations of Machine Learning, 2nd edition by Mehryar Mohri Afshin Rostamizadeh, Ameet Talwalkar, 2018 Massachusetts Institute of Technology. 3. Expert Systems: Principles and Programming/ Joseph C. Giarratano and Gary Riley, 4th edition, 2005.			
Supporting websites				
The physical environment for teaching	☐ **√ Class room**	☐ labs	☐ Virtual educational platform	☐ Others
Necessary equipment and software	**WEKA**			
Supporting people with special needs				
For technical support				

Course learning outcomes (S= *Skills, C= Competences K= Knowledge,)*

No.	Course learning outcomes	The associated program learning output code
	Knowledge	
K1	Understanding the fundamental concepts of machine learning algorithms and models.	MK4
K2	To become familiar with regression methods, classification methods, and clustering methods.	MK4
K3	Understand the types of problems that machine learning algorithms can solve.	MK4
K4	Understanding various machine learning algorithms in a range of real-world applications.	MK4
	Skills	
S1	To use different datasets in applying a wide variety of supervised and unsupervised machine learning algorithms and evaluating the models generated from these datasets.	MS4
S2	To design and implement machine learning solutions to classification, regression, and clustering problems.	MS4
S3	To apply different machine learning algorithms and models to real-world problems and use these machine learning methods in solving problems.	MS4
S4	To evaluate and interpret the results of machine learning algorithms.	MS4
	Competences	
C1	To apply the main concepts of machine learning algorithms for problems solving in real life.	MC1
C2	To build smart applications based on machine learning algorithms.	MC3
C3	To create effective applications that match the requirements and needs of the labor market based on machine learning algorithms.	MC3

Mechanisms for direct evaluation of learning outcomes

Type of assessment / learning style	Fully electronic learning	Blended learning	Traditional Learning (Theory Learning)	Traditional Learning (Practical Learning)
First exam	0	0	**%20**	0
Second / midterm exam	%30	%30	**%20**	30%
Participation / practical applications	0	0	**10**	30%
Asynchronous interactive activities	%30	%30	**0**	0
final exam	%40	%40	**%50**	40%

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Note: Asynchronous interactive activities are activities, tasks, projects, assignments, research, studies, projects, work within student groups ... etc, which the student carries out on his own, through the virtual platform without a direct encounter with the subject teacher.

Schedule of simultaneous / face-to-face encounters and their topics

Week	Subject	learning style*	Reference **
1	Class overview: Class organization, topics overview, software etc. Introduction to ML. What Is Machine Learning?	Lectures	Textbook1 Pages: 1 - 7
2	Why Use Machine Learning? Examples of Applications Types of Machine Learning Systems	Lectures	Textbook1 Pages: 8-23
3	Main Challenges of Machine Learning What Is Testing and Validating	Lectures	Textbook1 Pages: 23-35
4	Classification. MNIST Training a Binary Classifier Performance Measures Measuring Accuracy Using Cross-Validation Confusion Matrix	Lectures	Textbook1 Pages: 85 -90
5	Precision and Recall Precision/Recall Trade-off The ROC Curve Multiclass Classification	Lectures	Textbook1 Pages: 92 - 100
6	Error Analysis Multi-label Classification Multioutput Classification Exercises	Lectures	Textbook1 Pages: 102-108
7	Linear Regression The Normal Equation Computational Complexity Gradient Descent Batch Gradient Descent Stochastic Gradient Descent Mini-batch Gradient Descent Polynomial Regression	Lectures	Textbook1 Pages: 112 - 128
8	Learning Curves 130 Regularized Linear Models 134 Ridge Regression 135 Lasso Regression 137 Elastic Net 140 Early Stopping 141	Lectures	Textbook1 Pages: 130 - 150

	Logistic Regression 142 Estimating Probabilities 143 Training and Cost Function 144 Decision Boundaries 145 Softmax Regression 148 Exercises		
9	Support Vector Machines. Linear SVM Classification 153 Soft Margin Classification 154 Nonlinear SVM Classification 157 Polynomial Kernel 158 Similarity Features 159 Gaussian RBF Kernel 160 Computational Complexity 162	Lectures	Textbook1 Pages: 153 - 162
10	SVM Regression 162 Under the Hood 164 Decision Function and Predictions 165 Training Objective 166 Quadratic Programming 167 The Dual Problem 168 Kernelized SVMs	Lectures	Textbook1 Pages: 162 - 170
11	Selected review questions and exercises	Lectures	Textbook1 Pages:
12	Decision Trees. 175 Training and Visualizing a Decision Tree 175 Making Predictions 176 Estimating Class Probabilities 178 The CART Training Algorithm 179	Lectures	Textbook1 Pages: 175 - 179
13	Computational Complexity 180 Gini Impurity or Entropy? 180 Regularization Hyperparameters 181 Regression 183 Instability 185 Exercises	Lectures	Textbook1 Pages: 180 - 185
14	Unsupervised Learning Techniques 235 Clustering 236 K-Means 238 Limits of K-Means 248 Using Clustering for Image Segmentation 249 Using Clustering for Preprocessing 251 Using Clustering for Semi-Supervised Learning 253 DBSCAN 255	Lectures	Textbook1 Pages: 235-255
15	Other Clustering Algorithms 258	Lectures	Textbook1

	Gaussian Mixtures 260 Anomaly Detection Using Gaussian Mixtures 266 Selecting the Number of Clusters 267 Bayesian Gaussian Mixture Models 270 Other Algorithms for Anomaly and Novelty Detection 274 Exercises		Pages: 258-274
16	**Final Exam**		

*** Learning styles: Lecture, flipped learning, learning through projects, learning through problem solving, participatory learning ... etc.**

**** Reference: Pages in a book, database, recorded lecture, content on the e-learning platform, video, website ... etc.**