Jordan University of Science & Technology

Faculty of Computer & Information Technology

Department of Computer Science

Curriculum for the bachelor's degree

In

Artificial Intelligence

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Program Overview:

The Artificial Intelligence program was established to enhance theoretical and practical learning in the fields of artificial intelligence. The program includes an integrated and advanced curriculum that includes various specialized technical topics. The program provides students with scientific and practical experience in fundamental skills such as: artificial intelligence programming, machine learning, deep learning, computer vision, natural language processing, robotics, electronic games, intelligent systems, and information and network protection.

The Artificial Intelligence program seeks to achieve Jordanian national accreditation and international accreditation such as (ABET), and the study plan is consistent with reference programs at prestigious international universities.

• Carnegie Mellon University: **Link**

• University of Pennsylvania: **Link**

• Illinois Institute of Technology: **Link**

Vision

To be a leader in Artificial Intelligence education and research, contributing to innovative solutions and advancements that empower communities and drive technological transformation in Jordan and beyond.

Mission

Providing a high-quality education that equips students with advanced knowledge and practical skills in Artificial Intelligence. Through cutting-edge research and collaboration with industry partners, we strive to develop intelligent solutions that address societal challenges, promote technological advancement, and foster economic growth. We are committed to creating a dynamic learning environment that encourages creativity, critical thinking, and lifelong learning.

Program Educational Objectives

The objective of the B.Sc. in AI program is to produce graduates that will be able to:

1. PEO1 (Problem Solving): Gain in-depth knowledge of Computing and Artificial Intelligence principles and techniques and apply them effectively and proficiently to solve real-life problems.
2. PEO2 (Self-Motivated and Life-Long Learning): Promote sustainable learning by developing transferable skills and knowledge to keep up with the evolving Artificial Intelligence technologies, meet the demands of the rapidly changing labor market, and pursue higher degrees in different subfields of Artificial Intelligence.

3. PEO3 (Leadership and Teamwork): Improve the ability to work effectively and productively as a leader or a team member toward accomplishing common goals.
4. PEO4 (Community Support): Maintain strong relationships with the local, regional, and international communities by contributing to economic growth and social development.

Student Outcomes

Graduates of the AI program will have the ability to:

1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed and equitable judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
6. Apply computer science and artificial intelligence theory and software development fundamentals to produce computing-based solutions.

Course Numbering Convention

Digit	Meaning	Explanation	
Hundreds	Course Level	1	First Year
		2	Second Year
		3	Third Year
		4	Fourth Year
Tens	Course Subject	0	Basic Principles
		1	Programming
		2	Database
		3	-
		4	Networks
		5	Applications
		6	Information Hiding
		7	Systems and Systems Software
		8	Miscellaneous
		9	Special Topics and Training
Ones	Course Sequence	Course sequence number within the subject area	

The University Codes are as follows:

Code	Department
CIS	Computer Information Systems (CIS)
CS	Computer Science (CS)
SE	Software Engineering (SE)
CE	Computer Engineering (CE)
MATH	Mathematics (MATH)
CY	Cybersecurity (CY)

Study Plan for the Artificial Intelligence Program

A Bachelor of Science (B.Sc.) degree in Artificial Intelligence at faculty of Computer and Information Technology at JUST is awarded in accordance with the statute stated by JUST regulations for B.Sc. awarding issued by the Dean's Council based on 1987 law for awarding scientific degrees and certifications at JUST after completing (132) credit hours successfully, distributed as indicated in the following table:

Table (1)

Requirements	Mandatory	Elective	Total
University Requirements	16	9	25
Faculty Requirements	24	0	24
Departmental Requirements	74	9	83
Total	**114**	**18**	**132**

1. University Requirements (25 CHs) classified as:

1-a) University Mandatory Courses (16 CHs).
1-b) University Elective Courses (9 CHs).

2. Faculty Requirements (24 CHs) shown in table (2):

Table (2): Mandatory Faculty Requirements

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
HSS101MATH	Calculus I	3	3	0	-
HSS102MATH	Calculus 2	3	3	0	Passing HSS101MATH
HSS241MATH	Discrete Mathematics	3	3	0	-
HSS101CS	Introduction to Programming	2	2	0	CIS 99 or Concurrent
HSS101CS	Introduction to Programming (Lab)	1	0	2	Concurrent with HSS101CS
HSS103SE	Introduction to Information Technology	3	3	0	Concurrent with HSS101CS
HSS112SE	Introduction to Object-Oriented Programming	2	2	0	Passing HSS101CS
HSS112SE	Introduction to Object-Oriented Programming (Lab)	1	0	2	Concurrent with HSS112SE
HSS211CS	Data Structures	3	3	0	HSS241MATH and passing HSS112SE
CIS 221	Fundamentals of Database Systems	3	3	0	HSS211CS

3-a) Department mandatory requirements (74 CHs):

Table (3): Mandatory Department

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
AI 240	Introduction to Artificial Intelligence	3	3	0	HSS112SE+AI244
AI 244	Artificial Intelligence Programming	2	2	0	HSS101CS
AI 245	Artificial Intelligence Programming Laboratory	1	0	2	AI 244 or Concurrent
AI 249	Machine Learning	3	3	0	AI 244+Math140+Math233
AI 250	Machine Learning Laboratory	1	0	2	AI 249 or Concurrent
AI275	Digital Logic Design and Computer Organization	3	3	0	HSS101CS
AI 328	Big Data Processing	3	3	0	CIS 221
AI 329	Big Data Processing Laboratory	1	0	2	AI 328 or Concurrent
AI 342	Deep Learning	3	3	0	AI 249
AI 343	Deep Learning Laboratory	1	0	2	AI 250+AI 342 or Concurrent
AI 350	Data Science	3	3	0	AI 328+AI249
AI 362	Computer Networks and Security	3	3	0	HSS211CS
CS 375	Operating Systems	3	3	0	AI275
AI 375	Digital Image Processing	3	3	0	CS 284 + Math 140
AI 376	Digital Image Processing Laboratory	1	0	2	AI 375 or Concurrent
AI 378	Intelligent Embedded Systems	3	3	0	CS 375+AI 362
AI 445	Natural Language Processing	3	3	0	AI 342
AI 446	Natural Language Processing Laboratory	1	0	2	AI 445 or Concurrent
AI 447	Computer Vision	2	2	0	AI 342 + AI 375+AI 376
AI 448	Computer Vision Laboratory	1	0	2	AI 447 or Concurrent
AI 471	Artificial Intelligence for Games and Virtual Reality	3	3	0	AI 342
AI 472	Artificial Intelligence for Games and Virtual Reality Laboratory	1	0	2	AI 471 or Concurrent
AI 477	Robotics	3	3	0	AI 342+AI 378
AI 478	Robotics Laboratory	1	0	2	AI 477 or Concurrent
AI 490	Internship	3	3	0	Passing 90 CHs or department approval
AI 491	Graduation Project (1)	1	1	0	Passing 90 CHs
AI 492	Graduation Project (2)	3	3	0	AI 491

HSS101PHY	General Physics (1)	3	3	0	-
Math 140	Linear Algebra	3	3	0	MATH101
CS 284	Analysis and Design of Algorithms	3	3	0	HSS211CS+HSS233MATH
HSS233Math	Probability & Statistics (for computer science students)	3	3	0	HSS102MATH
CIS 201	Introduction to Web Design	1	0	3	HSS112SE
CIS 203	Communication and Professional Ethics	2	2	0	-

3-b) Department Elective Requirements (9 CHs):

Chosen by the student from the below list of courses, provided that at least **3 CHs** of them are from the Department of Artificial Intelligence*.

Table (4): Elective Department

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
AI 356	Information Retrieval	3	3	0	CIS 221 + AI 249
AI 365	Information Security and Privacy	3	3	0	AI 240
AI 381	Machine Learning Operations	3	3	0	AI249 + AI 328
AI 421	Cloud Computing	3	3	0	AI 328
AI 442	Artificial Intelligence Planning	3	3	0	AI 380
AI 443	Multi-Agent Systems	3	3	0	AI 471
AI 452	Semantic Web	3	3	0	CIS 201
AI 453	Social Networks Analysis	3	3	0	AI 356
AI 454	Business Intelligence	3	3	0	AI 350
AI 455	Pattern Recognition	3	3	0	AI 342
AI 457	Recommender Systems	3	3	0	AI 378
AI 481	Artificial Intelligence for Medicine and Healthcare	3	3	0	AI 342
AI 482	Artificial Intelligence for Computational Biology and Bioinformatics	3	3	0	AI 342
AI 483	Artificial Intelligence for Financial and Industrial Applications	3	3	0	AI 342
AI 484	Fuzzy Logic	3	3	0	CS 284
AI 485	Drones and Autonomous Systems	3	3	0	AI 477
AI 494	Research Methods in Artificial Intelligence	3	3	0	AI 342

*The student is exempt from studying 6 CHs from the optional courses based Table (4), if s/he joins one of the international academies specialized in offering technical courses or joins a technical training course offered in the college in which the number of training hours exceeds 150 hours, provided that s/he obtains an internationally accredited certificate for that course.

AI 495-I	Special Topics in Artificial Intelligence (1)	1	1	0	Dept. Approval
AI 495-II	Special Topics in Artificial Intelligence (2)	2	2	0	Dept. Approval
AI 495-III	Special Topics in Artificial Intelligence (3)	3	3	0	Dept. Approval
	400-level or higher CIT's course	3	3	0	Dept. approval

The student is awarded a Bachelor's degree in Artificial Intelligence program from the Faculty of Computer and Information Technology after successfully completing (132 credit hours), of which the student studies: (107 credit hours) from within the college and department, distributed over (159 contact hours), distributed for contact between theoretical and practical education, where the percentage of practical contact is approximately (25%) and the percentage of theoretical contact is approximately (75%).

The following table shows the percentages of practical parts in the department's courses, excluding elective courses:

Course Code	**Course Name**	Credit Hours	Theory Hours	Practice Hours	**Notes**
HSS101CS	Introduction to Programming	2	2	0	-
HSS101CS	Introduction to Programming (LAB)	1	0	2	Practical Course
HSS112SE	Introduction to Object-Oriented Programming	2	2	0	-
HSS112SE	Introduction to Object-Oriented Programming (LAB)	1	0	2	Practical Course
HSS211CS	Data Structures	3	3	0	Project-Based
CS 284	Analysis and Design of Algorithms	3	3	0	Project-Based
AI 240	Introduction to Artificial Intelligence	3	3	0	Project-Based
AI 244	Artificial Intelligence Programming	2	2	0	-
AI 245	Artificial Intelligence Programming Laboratory	1	0	2	Full Practical Course
AI 250	Machine Learning Laboratory	1	0	2	Full Practical Course
AI275	Digital Logic Design and Computer Organization	3	3	0	Project-Based
AI 329	Big Data Processing Laboratory	1	0	2	Full Practical Course
AI 343	Deep Learning Laboratory	1	0	2	Full Practical Course
AI 350	Data Science	3	3	0	Project-Based
AI 362	Computer Networks and Security	3	3	0	Project-Based
AI 376	Digital Image Processing Laboratory	1	0	2	Full Practical Course
AI 378	Intelligent Embedded Systems	3	3	0	Project-Based
AI 446	Natural Language Processing Laboratory	1	0	2	Full Practical Course
AI 448	Computer Vision Laboratory	1	0	2	Full Practical Course
AI 472	Artificial Intelligence for Games and Virtual Reality Laboratory	1	0	2	Full Practical Course
AI 478	Robotics Laboratory	1	0	2	Full Practical Course
AI 490	Internship	3	3	0	90-hour Practical
AI 491	Graduation Project (1)	1	1	0	Project-Based
AI 492	Graduation Project (2)	3	3	0	Project-Based
CIS 201	Introduction to Web Design	1	0	3	Full Practical Course
			Full Practical 25 Hrs. - 23%		**Project-Based 30 Hrs. – 28%**
			TOTAL		**51%**

Matrix Linking the Department's Courses to the Program Outcomes

Code	Course	SO1	SO2	SO3	SO4	SO5	SO6
AI 240	Introduction to Artificial Intelligence	✓					✓
AI 244	Artificial Intelligence Programming	✓	✓				
AI 245	Artificial Intelligence Programming Laboratory		✓				✓
AI 249	Machine Learning	✓	✓				
AI 250	Machine Learning Laboratory		✓				✓
AI275	Digital Logic Design and Computer Organization	✓	✓				
AI 328	Big Data Processing	✓	✓				
AI 329	Big Data Processing Laboratory		✓				✓
AI 342	Deep Learning	✓	✓				
AI 343	Deep Learning Laboratory		✓				✓
AI 375	Digital Image Processing	✓	✓				
AI 376	Digital Image Processing Laboratory		✓				✓
AI 350	Data Science	**Not yet offered**					
AI 362	Computer Networks and Security						
AI 378	Intelligent Embedded Systems						
AI 445	Natural Language Processing						
AI 446	Natural Language Processing Laboratory						
AI 447	Computer Vision						
AI 448	Computer Vision Laboratory						
AI 471	Artificial Intelligence for Games and Virtual Reality						
AI 472	Artificial Intelligence for Games and Virtual Reality Laboratory						
AI 477	Robotics						
AI 478	Robotics Laboratory						
AI 490	Internship						
AI 491	Graduation Project (1)						
AI 492	Graduation Project (2)						

Matrix Linking the Department's Courses to the Jordanian National Qualifications Framework (JQNF) Descriptors

Code	Course	L7K1	L7S1	L7S2	L7S3	L7C1	L7C2	L7C3	L7C4
AI 240	Introduction to Artificial Intelligence	✓							✓
AI 244	Artificial Intelligence Programming	✓					✓		
AI 245	Artificial Intelligence Programming Laboratory			✓	✓	✓			
AI 249	Machine Learning	✓							✓
AI 250	Machine Learning Laboratory			✓	✓	✓			
AI275	Digital Logic Design and Computer Organization	✓							✓
AI 328	Big Data Processing	✓							✓
AI 329	Big Data Processing Laboratory			✓	✓	✓			
AI 342	Deep Learning	✓							✓
AI 343	Deep Learning Laboratory			✓	✓	✓			
AI 375	Digital Image Processing	✓							✓
AI 376	Digital Image Processing Laboratory			✓	✓	✓			
AI 350	Data Science	**Not yet offered**							

AI 362	Computer Networks and Security	
AI 378	Intelligent Embedded Systems	
AI 445	Natural Language Processing	
AI 446	Natural Language Processing Laboratory	
AI 447	Computer Vision	
AI 448	Computer Vision Laboratory	
AI 471	Artificial Intelligence for Games and Virtual Reality	
AI 472	Artificial Intelligence for Games and Virtual Reality Laboratory	
AI 477	Robotics	
AI 478	Robotics Laboratory	
AI 490	Internship	
AI 491	Graduation Project (1)	
AI 492	Graduation Project (2)	

A student may be exempted from taking up to **6 credit hours of elective courses**, subject to department approval, if they have obtained an internationally recognized certification for a technical training course, provided that the training hours exceed 150 hours for every 3 credit hours. Additionally, the following courses qualify the student to obtain one of the global certifications as follows:

Academic Courses	Equivalent Certificate	# Equivalent C.H.s
AI 244 Artificial Intelligence Programming **AI 245** Artificial Intelligence Programming LAB	• EITC/CP/PPF Python Programming Fundamentals	**3**
AI 240 Introduction to Artificial Intelligence	• CAIE Certified Artificial Intelligence (AI) Expert	**3**
AI 249 Machine Learning **AI 250** Machine Learning LAB	• EITC/AI/MLP Machine Learning with Python • IBM Machine Learning Professional Certificate	**4**
AI 342 Deep Learning **AI 343** Deep Learning Laboratory	• ARTiBA Artificial Intelligence Engineer (AiE) • EITC/AI/ADL Advanced Deep Learning	**4**
AI 362 Computer Networks and Security **AI 365** Information Security and Privacy	• Cisco Certified Network Associate (CCNA)/By CISCO • CompTIA Network+ / By CompTIA • Cisco Certified Network Associate Security (CCNA Security) • Certified Information Systems Security Professional (CISSP)	**6**
AI 421 Cloud Computing	• CompTIA Cloud+ • Microsoft Certified: Azure AI Engineer Associate	**3**
AI 454 Business Intelligence	• Certified AI Transformation Leader (CAITL™)	**3**
AI 445 Natural Language Processing **AI 446** Natural Language Processing LAB **AI 447** Computer Vision	• Microsoft Certified: Azure AI Engineer Associate	**7**
AI 477 Robotics **AI 478** Robotics Laboratory	• Applied AI and Robotics with NVIDIA Jetson Nano	**4**

Recommended Study Plan

1st Year			
1st Semester			
Course Number	**Course Name**	**# CH**	**Prerequisite**
HSS101CS	Introduction to Programming	2	CIS 99 *(or concurrent)*
HSS101CS	Introduction to Programming (Practical)	1	Concurrent with HSS101CS
HSS103SE	Introduction to IT	3	Concurrent with HSS101CS
HSS101MATH	Calculus I	3	-
HSS241Math	Discrete Mathematics	3	-
HSS 110	Leader and Social Responsibility	3	-
LG 101	Communication Skills in English	3	Pass LG 099 or passing English exam
	Total	**18**	
2nd Semester			
HSS112SE	Introduction to Object-Oriented Programming	2	Passing HSS101CS
HSS112SE	Introduction to Object-Oriented Programming (Practical)	1	Concurrent with HSS112SE
AI 244	Artificial Intelligence Programming	2	HSS101CS
AI 245	Artificial Intelligence Programming Laboratory	1	AI 244 or Concurrent
Math 140	Linear Algebra	3	HSS101MATH
HSS102MATH	Calculus 2	3	HSS101MATH
CIS 203	Communication and Professional Ethics	2	-
ARB 102	Communication Skills in Arabic	3	-
	Total	**17**	

2nd Year			
1st Semester			
Course Number	**Course Name**	**# CH**	**Prerequisite**
AI 240	Introduction to Artificial Intelligence	3	HSS112SE+AI244
HSS233MATH	Probability & Statistics (for computer science students)	3	HSS102MATH
HSS211CS	Data Structures	3	HSS241MATH AND passing HSS112SE
AI 275	Digital Design and Computer Architecture	3	HSS101CS
HSS101PHY	General Physics (1)	3	-
-	University Elective	3	-
	Total	**18**	
2nd Semester			
CS 284	Analysis and Design of Algorithms	3	HSS211CS + HSS233MATH
MS 100	Military Science	3	-
AI 249	Machine Learning	3	AI 244+Math140+HSS233Math
AI 250	Machine Learning Laboratory	1	AI 249 or Concurrent
CIS 221	Fundamentals of Database Systems	3	HSS211CS
-	University Elective	3	-
	Total	**16**	

3rd Year			
1st Semester			
Course Number	**Course Name**	**# CH**	**Prerequisite**
AI 375	Operating Systems	3	AI275
AI 328	Big Data Processing	3	CIS 221
AI 329	Big Data Processing Laboratory	1	AI 250+AI 328 or Concurrent
AI 375	Digital Image Processing	3	CS 284 + Math 140
AI 376	Digital Image Processing Laboratory	1	AI 375 or Concurrent
AI 362	Computer Networks and Security	3	HSS211CS
-	University Elective	3	-
	Total	**17**	
2nd Semester			
AI 350	Data Science	3	AI 328
AI 342	Deep Learning	3	AI 249
AI 343	Deep Learning Laboratory	1	AI 250+AI 342 or Concurrent
AI 378	Intelligent Embedded Systems	3	CS 375+AI 362
CIS 201	Introduction to Web Design	1	HSS112SE
HSS 119	Entrepreneurship and Innovation	2	-
-	Department Elective	3	-
	Total	**16**	
3rd Semester (Summer)			
AI 490	Internship	3	Passing 90 CHs or department approval
	Total	**3**	

4th Year			
1st Semester			
Course Number	**Course Name**	**# CH**	**Prerequisite**
AI 445	Natural Language Processing	3	AI 342
AI 446	Natural Language Processing Laboratory	1	AI 445 or Concurrent
AI 447	Computer Vision	2	AI 342 + AI 375+AI 376
AI 448	Computer Vision Laboratory	1	AI 447 or Concurrent
AI 491	Graduation Project (1)	1	Passing 90 CHs
LG 103	Life Skills	2	-
-	Department Elective	3	-
	Total	**13**	
2nd Semester			
AI 477	Robotics	3	AI 342
AI 478	Robotics Laboratory	1	AI 477 or Concurrent
AI 471	Artificial Intelligence for Games and Virtual Reality	3	AI 342
AI 471	Artificial Intelligence for Games and Virtual Reality Laboratory	1	AI 471 or Concurrent
AI 492	Graduation Project (2)	3	AI 491
-	Department Elective	3	-
	Total	**14**	

Courses Description
Artificial Intelligence Courses

AI 240: Introduction to Artificial Intelligence (Project-Based Learning) (3C=3H+0L)

Prerequisite: HSS112SE+AI244

An introduction to the basic knowledge representation, problem solving, and learning methods of artificial intelligence. Topics will include specific AI techniques, a range of application areas, and connections between AI and other areas of study (i.e., philosophy, psychology). Techniques may include heuristic search, automated reasoning, machine learning, deliberative planning and behavior-based agent control. Application areas include robotics, games, knowledge representation, and natural language processing. **This project-based course is designed to enhance students' practical skills in the field of artificial intelligence**.

AI 244: Artificial Intelligence Programming (2C=2H+0L)

Prerequisite: HSS101CS

This course provides the fundamentals of the Python programming language, along with programming best practices. Students will learn about several libraries in python, that solve many computational problems related to AI and Machine Learning (ML) tasks such as obtaining and handling real-world messy data, performing simple data manipulation, analysis and visualization, and building ML models.

AI 245: Artificial Intelligence Programming Laboratory (1C=0H+2L)

Prerequisite: AI 244 or Concurrent

This laboratory provides a practical work on the fundamentals of the Python programming language, along with programming best practices with an in-depth understanding of "AI in practice" where students will gain practical experience on how to apply several techniques in practical tasks using programming language as python and popular Python AI libraries.

AI 249: Machine Learning (3C=3H+0L)

Prerequisite: AI 244+Math140+Math233

This course provides a broad introduction to principles, algorithms, and applications of machine learning. Topics include basic review of vital mathematical, statistical and algorithmic concepts, supervised learning, curve fitting, linear models for regression (basic functions, gradient search, bias-variance, Bayesian regression, and evidence approximation), linear models for classification such as decision trees, discrimination functions, probabilistic generative models, probabilistic discriminative models, Laplace approximation. The course will also discuss Bayesian logistic regression, linear prediction with regularization. Lasso and Elastic Net, Feature selection and model selection. Other topics include supervised classification, KNN theory, principal component analysis, support vector machines, and reinforcement learning.

AI 250: Machine Learning Laboratory (1C=0H+2L)

Prerequisite: AI 249 or Concurrent

This laboratory provides practical work on the principles, algorithms, and applications of machine learning. Topics include basic review of vital mathematical, statistical and algorithmic concepts, supervised learning, curve fitting, linear models for regression, linear models for classification such as decision trees, discrimination functions, probabilistic generative models, probabilistic discriminative models, Laplace approximation. The laboratory will also discuss Bayesian logistic regression, linear prediction with regularization, Lasso and Elastic Net, feature selection and model selection. Other topics include supervised classification, KNN theory, principal component analysis and support vector machines.

AI275: Digital Logic Design And Computer Organization (Project-Based Learning) (3C=3H+0L)

Prerequisite: HSS101CS

This course introduces students to binary systems; boolean algebra and logic gates; simplification of boolean functions; combinational logic; design of combinational logic and hierarchical logic design; sequential logic; registers, ALU design, computer architecture MARIE, Simulator, and ISA. **This project-based course is designed to enhance students' practical skills in digital logic design.**

AI 328: Big Data Processing (3C=3H+0L)

Prerequisite: CIS 221

This course addresses distributed storage and large data set processing focusing on architectures and technologies. Students will experience various data genres and management tools appropriate for processing big data. Students will learn all about Hadoop and its framework consisting of tools for distributed storage and data processing, to an open-source framework while addressing distributed storage and large data set processing. Additionally, students learn about other elements such as NoSQL databases, and competing technologies. Through guided hands-on tutorials, students will become familiar with techniques using real-time and semi-structured data examples in order to design business solutions to manage big data projects.

AI 329: Big Data Processing Laboratory (1C=0H+2L)

Prerequisite: AI 328 or Concurrent

This laboratory work enables students to learn and practice all about Hadoop and its framework consisting of tools for distributed storage and data processing, to an open-source framework while addressing distributed storage and large data set processing. Through guided hands-on worksheets, students will become familiar with techniques using real-time and semi-structured data examples in order to design business solutions to manage big data projects.

AI 342: Deep Learning (3C=3H+0L)

Prerequisite: AI 249

This course will introduce students to the concept of deep learning and its key principles. The course covers feed-forward neural networks, convolutional neural networks (object classification, object detection, face verification, style transfer), recurrent neural network (natural language processing, speech recognition), sequence modelling, techniques to improve neural networks (regularization and optimizations, hyperparameter tuning, deep learning frameworks), generative adversarial networks, deep reinforcement learning, and adversarial attacks. By the end of the course, students will be able to build, train and apply fully connected deep neural networks, and to know how to implement efficient neural networks using the most popular deep learning libraries such as Keras, PyTorch, and TensorFlow.

AI 343: Deep Learning Laboratory (1C=0H+2L)

Prerequisite: AI 342 or Concurrent

This laboratory provides a practical work on the concept of deep learning and its key principles. The practical work will make students able to build, train and apply fully connected deep neural networks using the most popular libraries for deep learning such as Keras, PyTorch, and TensorFlow. Students will be able to implement and apply some deep reinforcement learning models.

AI 350: Data Science (Project-Based Learning) (3C=3H+0L)

Prerequisite: AI 328+AI249

This course provides students with key concepts in data science and suitable programming skills to support these concepts. Specific topics include definition of data science and its relationships with other fields; importance of data science and its driving forces; data acquisition and exploration; data profiling; data cleaning; data quality; feature selection taking into consideration structured and unstructured data; model selection; result analysis and visualization of data and results. Many python packages necessary for data science and analytics are also covered. **This project-based course is designed to enhance students' practical skills in data science.**

AI 356: Information Retrieval (3C=3H+0L)

Prerequisite: CIS 221 + AI 249

This course aims to understand information retrieval algorithms and identify challenging problems on the Web. Topics include keyword-based retrieval, file structures, thesaurus construction, lexical analysis, stemming, term weighting, associative indexing, Boolean operations, string searching, and matching techniques, document modeling and inverted index construction and compression, vector space model and ranking methods, probabilistic and language models, evaluation methods, relevance feedback, query expansion. The course also covers web search fundamentals, an example of topics includes web search engine architecture, web crawling and indexing, web structure, and usage analytics.

AI 362: Computer Networks and Security (Project-based learning) (3C=3H+0L)

Prerequisite: HSS211CS

In this course, students will investigate core networking concepts, concentrating on network architecture, various communication protocols, and the technologies that foster connections within local and wide-area networks. The syllabus includes important topics such as network topologies, the OSI model, TCP/IP protocols, and routing and switching methodologies. Furthermore, the course will address pressing security concerns by examining the risks and vulnerabilities faced by modern networks. Students will gain knowledge about a variety of security protocols, encryption methods, and best practices for protecting network infrastructure. By the end of the course, students will be equipped with the skills necessary to build and manage secure networks while effectively tackling security challenges in an interconnected digital environment. **This project-based course is designed to enhance students' practical skills in securing computer networks.**

AI 365: Information Security and Privacy (3C=3H+0L)

Prerequisite: AI 240

This course covers the fundamental issues and first principles of security and information assurance. Security policies, models and mechanisms related to confidentiality, integrity, authentication, identification, and availability issues related to information and information systems. Basics of cryptography such as key management and digital signatures, etc. And network security such as PKI, IPsec, intrusion detection and prevention. Risk management, security assurance and secure design principles. Issues such as organizational security policy, legal and ethical issues in security, standards and methodologies for security evaluation and certification.

AI 375: Digital Image Processing (3C=3H+0L)

Prerequisite: CS 284 + Math 140

This course introduces students to image sampling and quantization, color, point operations, segmentation, morphological image processing, linear image filtering and correlation, image transforms, eigenimages, multiresolution image processing, noise reduction and restoration, feature extraction and recognition tasks, image registration. Emphasis is on the general principles of image processing. Students learn to apply material by implementing and investigating image processing algorithms.

AI 376: Digital Image Processing Laboratory (1C=0H+2L)

Prerequisite: AI 375 or Concurrent

This laboratory provides a practical work on image sampling and quantization, color, point operations, segmentation, morphological image processing, linear image filtering and correlation, image transforms, eigenimages, multiresolution image processing, noise reduction and restoration, feature extraction and recognition tasks, image registration. Students learn to apply image processing algorithms using professional tools, such as Python libraries and Matlab.

AI 378: Intelligent Embedded Systems (Project-Based Learning) (3C=3H+0L)

Prerequisite: CS 375+AI 362

This course aims at preparing students to the smart cities and Internet of Things (IoT) markets. The course introduces the building blocks of IoT systems and the underlying technologies that drive the IoT revolution. Part of the course will deal with developing real-world IoT applications/mobile application prototypes from the sensing level to the end-user applications to solve existing problems in the society. Moreover, the course utilizes AI algorithms to build models and large-scale systems to solve problems such as telco management, intelligent transportation, urban planning, real time crowd management, retail intelligence, and industry 4.0 using various data sources. **This project-based course is designed to enhance students' practical skills in intelligent systems.**

AI 381: Machine Learning Operations (Project-Based Learning) (3C=3H+0L)

Prerequisite: AI249 + AI 328

This course provides an in-depth exploration of Machine Learning Operations (MLOps), focusing on the practices and tools essential for deploying, managing, and scaling machine learning models in production environments. Students will learn how to bridge the gap between data science and IT operations, covering topics such as version control, containerization, continuous integration and deployment (CI/CD), monitoring, and model lifecycle management. The curriculum emphasizes practical skills, enabling students to implement automated workflows for model training, validation, and deployment, as well as strategies for ensuring model performance and reliability post-deployment. By the end of the course, students will be proficient in MLOps methodologies and equipped with the skills to effectively manage machine learning projects from development through to production, ensuring that they

are robust, scalable, and maintainable. **This project-based course is designed to enhance students' practical skills in managing machine learning processes.**

AI 421: Cloud Computing (3C=3H+0L)

Prerequisite: AI 328

The course introduces cloud computing, its techniques and main components. It covers the topics of data centers, virtualization, cloud storage and programming models. It discusses the motivating factors, benefits, challenges, and service models. It describes several concepts behind data center design and management. It also presents virtualization, data distribution, durability, consistency and redundancy.

AI 442: Artificial Intelligence Planning (3C=3H+0L)

Prerequisite: AI 272

Planning is a fundamental part of intelligent systems. It is the task of finding a sequence of actions needed to achieve a system its goals while optimizing the overall performance, intelligent planners can reason about the effects of actions, and efficiently searching the space of possible plans. Topics include action and plan representation, reactive systems, hierarchical and abstraction planning, case-based planning, machine learning in planning, multi-agent planning, Artificial Intelligence Planning for Robots, interacting with the environment, planning under uncertainty, plan execution, partial plans and plan refinement, task network and decomposition, Graphplan Algorithm, Pattern Databases, plan generation, planning modeling languages, and applications of planning.

AI 443: Multi-Agent Systems (3C=3H+0L)

Prerequisite: AI 471

A multi-agent system is composed of multiple autonomous entities such as sensor networks and robots, with distributed information, computational ability, and possibly ramified interests. This course serves as the foundation of multi-agent systems, including multi-agents reinforcement learning (MARL). Topics include an introduction to reinforcement learning, game theory, basic game representations and solution concepts, models of cooperation, extensive form games, repeated games, security games, coalitional and Bayesian games, multi-agent learning, voting, and problem-solving in networks, communication, social choice, mechanism design, auctions, and negotiation.

AI 445: Natural Language Processing (3C=3H+0L)

Prerequisite: AI 342

Natural language processing (NLP) is a crucial part of artificial intelligence (AI), modeling how people share information. This course explores current statistical and deep learning techniques for the automatic analysis of natural (human) language data. Topics: language modeling, word-sense disambiguation, morphological analysis, part-of-speech tagging, syntactic parsing, semantic interpretation, co-reference resolution, and discourse analysis. Applications: information extraction, question answering, speech recognition, interactive dialog systems, machine translation, sentiment analysis, and summarization.

AI 446: Natural Language Processing Laboratory (1C=0H+2L)

Prerequisite: AI 445 or Concurrent

This laboratory enables students to implement and operate key NLP approaches and applications, including information extraction, question answering, speech recognition, interactive dialog systems, machine translation, sentiment analysis, and summarization.

AI 447: Computer Vision (2C=2H+0L)

Prerequisite: AI 342 + AI 375

This course provides a comprehensive introduction to computer vision. It is therefore primarily concerned with the problem of capturing and making sense of digital images. The field draws heavily on many major subjects including digital image processing, artificial intelligence, feature extraction and selection, image classification and recognition, and scene understanding. It also discusses various emerging applications of deep learning in computer vision, such as: Attention and transformers, object detection and recognition, image segmentation, image/video classification, generative models (GANs, VAEs, autoregressive), and object tracking.

AI 448: Computer Vision Laboratory (1C=0H+1L)

Prerequisite: AI 447 or concurrent

This course provides a comprehensive introduction to computer vision. It is therefore primarily concerned with the problem of capturing and making sense of digital images. The field draws heavily on many major subjects including

digital image processing, artificial intelligence, feature extraction and selection, image classification and recognition, and scene understanding. It also discusses various emerging applications of deep learning in computer vision, such as: Attention and transformers, Object detection and recognition, Image segmentation, image/video classification, Generative models (GANs, VAEs, autoregressive), and object tracking.

AI 452: Semantic Web (3C=3H+0L)

Prerequisite: CIS 201

An introduction to semantic web technologies and their applications. Students will learn different aspects of web semantic representation and how to reason about data using ontologies. The course will introduce the existing technologies and how to apply semantic web technologies to current and potential real-world applications. Topics include the semantic web activity of W3C, semantic modeling and ontology representation, semantic web applications, logic for the semantic web, ontologies modeling and design using resource description framework (RDF) and web ontology language (OWL), and semantic web applications.

AI 453: Social Networks Analysis (Project-Based Learning) (3C=3H+0L)

Prerequisite: AI 356

An introduction to the concepts and methods of social network analysis. This course will introduce students to different techniques of extracting and analyzing large-scale network data and how to reason for it. Students will also learn about social networks structure, dynamics and evolution. Topics include methods for social network analysis, network models, graph representation, graph traversal algorithms, graph mining, link analysis and network community detection, information propagation on the web, and recommendations systems. Students will also learn how to use some social network analysis packages/tools. **This project-based course is designed to enhance students' practical skills in developing models to analyze social networks.**

AI 454 Business Intelligence (3C=3H+0L)

Prerequisite: AI 350

This course introduces the concepts of business intelligence and explores how business problems can be solved and then applying data mining tools and analytics to gain new insights into organizational operations. This course will put an emphasis on the differences between types of reporting and analytics, enterprise data warehousing, data management systems, decision support systems, knowledge management systems and big data. Case studies are used to explore the use of application software, web tools, success and limitations of BI as well as technical and social issues.

AI 455: Pattern Recognition (Project-Based Learning) (3C=3H+0L)

Prerequisite: AI 342

This course covers pattern recognition techniques that are concerned with the theory and algorithms of putting abstract objects, e.g., measurements made on physical objects, into categories. Typically, the categories are assumed to be known in advance, although there are techniques to learn the categories (clustering). Topics include pattern recognition systems, preprocessing and feature extraction, training methods, maximum likelihood and Bayesian parameter estimation, linear discriminant, perceptron learning, optimization by Gradient descent, theories of supervised and unsupervised learning techniques with applications, object classification and recognition, artificial neural networks, mixture modeling, expectation-maximization, hidden Markov models, Viterbi algorithm, Baum-Welch algorithm, linear dynamical systems, Kalman filtering, reinforcement learning with human interaction, and combination of multiple classifiers. **This project-based course is designed to enhance students' practical skills in pattern recognition.**

AI 457: Recommender Systems (Project-Based Learning) (3C=3H+0L)

Prerequisite: AI 378

This course will introduce students to a range of approaches for building recommender systems. Topics are collaborative, content-based, knowledge-based, and hybrid algorithms, filtering techniques, dimension reduction techniques for the user-product preference space, candidate generation, scoring, and re-ranking, and evaluation and metrics for recommender systems. Students will implement recommendation algorithms using an open-source toolkit and conduct experimental evaluations. **This project-based course is designed to enhance students' practical skills in implementing recommendation systems.**

AI 471: Artificial Intelligence for Games and Virtual Reality (3C=3H+0L)

Prerequisite: AI 342

The purpose of this course is to familiarize students with issues and techniques of Artificial Intelligence (AI) for computer games. Topics include mathematical background (a review that includes some basics, trigonometry, vectors, local space and world space), physics background (a review that includes topics like time, distance, mass, position, velocity, acceleration and force), state-driven agent design, create autonomously moving game agents, application as a simulation, designing the AI (players, teams, states, motions, maps, projectiles, triggers, decision making, path planning, perception, target selection, as well as strategies), graphs and graph search algorithms, scripting (creating a scripted finite state machine), goal-driven agent behavior, and fuzzy logic, all within the context of computer games.

AI 472: Artificial Intelligence for Games and Virtual Reality Laboratory (1C=0H+2L)

Prerequisite: AI 471

This laboratory work will familiarize students with techniques of Artificial Intelligence (AI) for computer games and virtual reality. Hands-on worksheets include state-driven agent design, application as a simulation, graph search algorithms, goal-driven agent behavior, virtual reality, augmented reality, and extended reality.

AI 477: Robotics (3C=3H+0L)

Prerequisite: AI 342

This course covers the fundamental elements of mobile robot systems from a computational standpoint and introduces the design and implementation of intelligent mobile robot systems. Topics include mobile robots control (sensing, vision, control, motion, kinematics theory, navigation, localization and perception), software control architectures, sensor interpretation, map building and navigation, computer vision and image processing, camera calibrations and multi-camera view, mobile robotics, multi-robot systems, task planning, agent architectures, and reasoning. Students program a small mobile robot to perform simple tasks in real-world environments.

AI 478: Robotics Laboratory (1C=0H+2L)

Prerequisite: AI 342

This laboratory provides a practical implementation of fundamental elements of mobile robot systems with several tools and platforms, such as Arduino. Students will design, program, test, and operate a small mobile robot to perform various intelligent tasks in real-world environments.

AI 481: Artificial Intelligence for Medicine and Healthcare (Project-based learning) (3C=3H+0L)

Prerequisite: AI 342

This course introduces the different applications of AI in the health care domain with a focus on medical data analytics. Data analytics has emerged as a promising tool for solving problems across many Health-related disciplines. This course provides a clear understanding of the analytical techniques currently available to solve several health problems. The course explains the novel techniques for acquiring, handling, retrieving, and making the best use of Health data. The course will bridge the gap between computer scientists and the domain-specific medical experts and help students gain more knowledge in this domain. **This project-based course is designed to enhance students' practical skills in healthcare applications.**

AI 482: Artificial Intelligence for Computational Biology and Bioinformatics (Project-based learning) (3C=3H+0L)

Prerequisite: AI 342

This course introduces artificial intelligence (AI) in bioinformatics, computational biology, and biomedicine. It covers topics related to complex biological analysis, the application of AI principles, and the integration of diverse biological content through different AI methods and technologies. The course will cover how to apply AI techniques such as data modelling, machine learning, deep learning, statistical methods, and data mining in Bioinformatics and Biomedicines problems. The course explores how to apply AI in bioinformatics technologies into several topics such as DNA, RNA, and protein structure and folding problems, drug discovery, digital health, genetics, and metabolic pathways. **This project-based course is designed to enhance students' practical skills in bioinformatics applications.**

AI 483: Artificial Intelligence for Financial and Industrial Applications (Project-based learning) (3C=3H+0L)

Prerequisite: AI 342

This course explores the role of emerging AI algorithms and techniques on financial decisions. This course introduces the basics of AI and its impact on financial services. It gives an overview of the potential implementations of AI within an organization. The course explores a deep dive into determining if the business is prepared for the future using several AI techniques. The course provides hands-on financial forecasting experience using several AI and machine learning techniques and grasp forecasting techniques on specific real-world financial data. **This project-based course is designed to enhance students' practical skills in finance and industry applications.**

AI 484: Fuzzy Logic (3C=3H+0L)

Prerequisite: CS 284

Introduction to fuzzy sets, fuzzy relations; fuzzy measures; fuzzy logic and approximate reasoning; applications of fuzzy systems in pattern recognition, control, and signal processing. The course aims to show the differences between fuzzy sets and crisp sets. Various terms used in the fuzzy sets and the grammar of fuzzy sets will be discussed in this course. Topics include how to model fuzzy sets, how to handle arithmetic of fuzzy quantities, and how to acquire operations with fuzzy relations.

AI 485: Drones and Autonomous Systems (Project-based learning) (3C=3H+0L)

Prerequisite: AI 477

Introduction to unmanned aerial systems (UAS) including drones and autonomous unmanned aerial vehicles (UAV) with sensors including those for obstacle avoidance, other instruments, and payloads that rely on complex algorithms and have various uses. The course aims at preparing the students to understand the commercial and research capabilities of drones including sensors, platforms, navigation, power source, propulsion, payloads, command, communication and control, range, altitude, speed, wide area surveillance. By the end of the course, the students will be able to understand systems view of drones with hardware and software including data collection, storage, and analytical requirements, and systems life cycle with needs and purpose: assessment, goals/objectives, requirements, testing and training. **This project-based course is designed to enhance students' practical skills in autonomous systems applications.**

AI 490: Internship (3C=3H+0L)

Prerequisite: Passing 90 CHs or department approval

A student is required to conduct training in one of the local organizations for at least six weeks for a period of 60 working days, presents a report from the organization to describe the effectiveness of the practice according to the training regulations.

AI 491: Graduation Project (1) (1C=1H+0L)

Prerequisite: Passing 90 CHs

The graduation project provides a unique opportunity for students in Artificial Intelligence program to apply their knowledge of the foundations, theory, and methods of AI and software development to address and provide solutions (i.e., developing software applications) to problems in industry, government and the non-profit sector and other areas. The course activities focus on a two semester-length project sponsored by a local organization if available. Typically, two to four students work together as a team on each graduation project. Each team is supervised by a faculty mentor and projects typically progress through several phases. This course includes the first stage of the graduation project where the student(s) should define, analyze the problem, and finally write a proposal. Then to present it to a predetermined committee in the department. It includes weekly meetings with the supervisors.

AI 492: Graduation Project (2) (3C=3H+0L)

Prerequisite: AI 491

This is the second stage of the graduation projects, which includes the practical aspects which are design, implementation and testing for the resulting project. Cooperative formative research, design, development, and testing of a sizable and realistic sociotechnical system, i.e., a solution to a real-world problem that includes both technical and human components. Students work as a team with a client on a real-world open-ended problem, and gain experience in Artificial Intelligence (problem definition, software development, iterative design), and in other fields relevant to the problem. Both student participation in the classroom and effective teamwork outside the classroom are stressed. It includes weekly meetings with the supervisors.

AI 494: Research Methods in Artificial Intelligence (3C=3H+0L)

Prerequisite: AI 342

This course provides students with a comprehensive understanding of research methodologies applicable to AI. Students will explore various qualitative and quantitative research techniques, emphasizing critical thinking, problem formulation, and data analysis relevant to AI topics. The curriculum includes discussions on the ethical considerations in AI research, literature review processes, and the development of research proposals. Through hands-on projects, students will engage in practical research activities, allowing them to apply their knowledge to real-world AI challenges. By the end of the course, students will be equipped to conduct independent research, contribute to ongoing studies in the field, and present their findings effectively.

AI 495-I: Special Topics in Artificial Intelligence (1) (1C=1H+0L)

Prerequisite: Dept. Approval

The department chooses a topic related to the field of Artificial Intelligence as needed. This course should cover state-of-the-art problems and solutions in Artificial Intelligence.

AI 495-II: Special Topics in Artificial Intelligence (2) (2C=2H+0L)

Prerequisite: Dept. Approval

The department chooses a topic related to the field of Artificial Intelligence as needed. This course should cover state-of-the-art problems and solutions in Artificial Intelligence.

AI 495-III: Special Topics in Artificial Intelligence (3) (3C=3H+0L)

Prerequisite: Dept. Approval

The department chooses a topic related to the field of Artificial Intelligence as needed. This course should cover state-of-the-art problems and solutions in Artificial Intelligence.