Course Specification
(Bachelor)

Course Title:	AI in Physics
Course Code:	PHYS 0374
Program:	BSc in Physics
Department:	Physics
College:	Science
Institution:	Majmaah University
Version:	2
Last Revision Date:	26/12/2024

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A. General information about the course:

1. Course Identification

1. Credit hours: 3(3.0.0)					
2. Course type					
A.	☐University	☐College	☒ Department	☐Track	☐Others
B.	☒ Required		☐ Elective		
3. Level/year at which this course is offered: (6th level/ third year)					
4. Course General Description:					

This course consists of providing a set of general artificial intelligence methods to be applied to physical systems including quantum systems. The course prepares to conduct a professional approach to match most suitable machine learning tools to a physical problem. It enables to apply artificial intelligence in both scientific research and applied science environments, including reinforcement learning and quantum machine learning. Moreover, the course explores the ethical and societal implications of basic AI, which are important considerations for Physical professionals working with AI. The course also includes basic programming assignments and projects, which will help physics students to develop practical skills in basic AI.

5. Pre-requirements for this course (if any)**:**

PHYS 0312

6. Co-requisites for this course (if any)**:**

NAN

7. Course Main Objective(s):

The students after the completion of this course would be able to:

1. Define the fundamental principles and concepts of artificial intelligence, including machine learning, natural language processing, and computer vision.
2. Explain the key applications of artificial intelligence in various fields, such as physics and define the impact of physics on machine learning.
3. Apply basic machine learning techniques to solve problems, using programming languages such as Python.
4. Use natural language processing tools to understand and analyze physical data.
5. Develop basic computer vision systems to recognize objects in images and videos.

6. Evaluate the ethical and societal implications of artificial intelligence, such as bias, privacy, and job displacement.
7. Communicate effectively about artificial intelligence, both orally and in writing, to non-technical audiences.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45 hours	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning	0	0

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**45 hours**
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
5.	**Others (specify)**	
Total		**45 hours**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	• Define the fundamental principles and concepts of artificial intelligence, including machine learning, natural language processing, and computer vision.	**K(1):** Recognize the basic knowledge of fundamental concepts in artificial intelligence, machine learning, natural language processing, and computer vision.	Lecture Exercises Quizzes Problem solving	Exams Quizzes Homework Assignments
1.2	• Explain the key applications of artificial intelligence in physical fields, such as	**K(2):** Understand the importance of artificial		

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	particle physics and molecular physics.	intelligence in physics laws		
1.3				
2.0	**Skills**			
2.1	• Apply basic machine learning techniques to solve physical problems, using programming languages such as Python.	**S(2):** Develop the skill for analysing/solving the physics-based problems using programming languages such as Python.	Oral quizzes Class discussion Class Activity	Exams Homework Assignments Presentations
2.2	• Use natural language processing tools to understand and analyze physical data.			
2.3	•			
3.0	**Values, autonomy, and responsibility**			
3.1	• Learn how to search for information through library and internet.	**V(1)**: Work effectively in groups as well as individually, Learn how to collect and classify the required topics using internet communication tools. **V(2):** Learn how to collect and classify the required topics using internet communication tools.	Give time bound task. Group Presentation Group assignments	Observation Group discussion Group Report e-learning quizzes
3.2	• Present a short report in a written form and orally using appropriate scientific language			
3.3	• Operate questions and communicate with teacher through solve problems and work in groups.			

C. Course Content

No	List of Topics	Contact Hours
1.	• Introduction to AI, Data Mining, Machine Learning, Natural Language Processing.	9 hours
2.	• Machine Learning Physics; Impact of Physics on Machine Learning; Statistical Physics of ML; Analog Computers; Quantum Computers.	6 hours

3.	• Machine Learning the Physical World from Subatomic to Cosmic Scales	6 hours
4.	• AI for Particle Physics, The Standard Model, Machine Learning for Particle Physics.	6 hours
5.	• Cut-Based Event Selection in a Particle Physics Experiment.	6 hours
6.	• AI for Molecular Physics	6 hours
7.	• AI for Condensed Matter Physics.	6 hours
Total		**45 hours**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	First Mid-Term exam	Week #6	**15%**
2.	Second Mid-Term exam	Week #11	**15%**
3.	E-learning quizzes	Once/ semester	**10%**
4.	Presentation	Once/ semester	**20%**
5.	Discussions	Every week	
6.	Home Work	Every week	
7.	Final exam	End of the semester	**40%**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	• **"AI FOR PHYSICS, 2023,** Author's: VOLKER KNECHT, CRC Press Taylor & Francis Group, LLC, 2023. • **"Artificial Intelligence: A Modern Approach", 2020,** Author's: Stuart Russell and Peter Norvig, Pearson; 4th edition, 2020.
Supportive References	• **" Hands-On Machine Learning with Scikit-Learn, Keras, and Tensorflow: Concepts, Tools, and Techniques to Build**

	Intelligent Systems", 2019, Author's: Aurelien Geron, O'Reilly Media; 2nd ed. Edition, 2019. • "**Artificial Intelligence Basics: A Non-Technical Introduction", 2019,** Author's: Tom Taulli, APress; 1st ed. edition (2 August 2019)
Electronic Materials	• Saudi Digital Library (SDL) • https://www.wikipedia.org/ • Web of Knowledge • Physics Today (web version) • MIT Courseware • www.eagle.co.uk/news/ppnews.html • http://faculty.mu.edu.sa/ • http://vlib.org/physics.html • http://dir.yahoo.com/science/physics • http://demonstrations.wolfram.com • http://askthephysicist.com • http:// cyberphysics.co.uk
Other Learning Materials	• Excel software for drawing graphs. • MS Office for writing reports and presentations.

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms, Physics Laboratory and computer with internet lab.
Technology equipment (projector, smart board, software)	Computer Lab. and internet lab, data show, Smart Board.
Other equipment (depending on the nature of the specialty)	Library with text book for search and revision, Wi-Fi internet connections

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Internal Reviewer committee	Direct
Effectiveness of Students assessment	Student Self-Assessment and Peer Assessment.	Indirect
Quality of learning resources	Peer Reviewer	Direct
The extent to which CLOs have been achieved	Internal Reviewer committee	Direct
Other	Internal Reviewer committee	Direct

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	
REFERENCE NO.	
DATE	