DeCAIR Course Syllabus Form

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Activity Number & Title	Activity 2.2: Designing and developing syllabi and content for the agreed upon courses in the new programs		
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Revision History

Version	Date	Author	Description	Action *	Page(s)
1	20/11/2021	Mohammad Abdel-majeed	Original (base) document	C	1-6
2	9/12/2021	Mohammad Abdel-majeed	Updated based on the feedback received after the ??????????????????	U	1-6
3					
4					

(*) Action: C = Creation, I = Insert, U = Update, R = Replace, D = Delete

Disclaimer

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Course title	Reinforcement Learning
Course number	0907755
Credit hours (lecture and lab)	3 (3 + 0)
ECTS (weekly contact and self-study load)	6 (3 + 3)
Prerequisites/co-requisites by course number and name	Applied Machine Learning (0907743)
Prerequisites by topic (other than the formal prerequisites above)	Students are assumed to have good background in machine learning and Python programming skills.
Level and type (compulsory, elective)	Masters' Elective course
Year of study and semester	First year, second semester or Second year, first semester
Catalogue description	The course is about prediction and control using reinforcement learning, including aspects of deep reinforcement learning, i.e., the application of deep neural networks-based functional approximation to reinforcement learning problems. The course covers theory and applications related to the following topics: Markov decision processes, value function approximation, policy gradient methods, actor-critic algorithms, integration of learning and planning, and exploration vs exploitation trade-offs. Term project.
Objectives	1. Learn how to define reinforcement learning (RL) tasks and the core principals behind RL, including policies, value functions, and deriving Bellman equations. 2. Implement in code common algorithms following code standards and libraries used in RL. 3. Understand and work with tabular methods (dynamic programming, Monte Carlo, and temporal difference) to solve classical control problems. 4. Understand and work with approximate solutions (deep Q network-based algorithms). 5. Learn the policy-based methods. 6. Recognize current advanced techniques and applications in RL.
Intended learning outcomes	Upon successful completion of this course, students will be able to:

No	Intended learning Outcome (ILO)	Program learning outcome (PLO)*
1	Demonstrate a sound understanding of the main reinforcement learning techniques and algorithms.	1
2	Solve problems using reinforcement-learning	3

	<table><tr><td></td><td>algorithms.</td><td></td></tr><tr><td>3</td><td>Communicate the development of reinforcement learning models through a detailed technical report and a short presentation.</td><td>4</td></tr><tr><td>4</td><td>Use Python and its specialized libraries to develop programs for solving RL problems.</td><td>3</td></tr></table>(*) The PLOs are listed in the appendix
Teaching and learning methods	Development of ILOs is promoted through the following teaching and learning methods: • The AI lab is open for the students to practice the practical aspects and solve the programming homework assignments. • The student attends the class presentations and participates in the discussions. • The student joins the related online team/group and participates in its discussions. • The student studies the reference material, including books and videos. • The student solves the programming assignments. • The student carries out a term project for solving a problem using unsupervised learning techniques. • The student develops a professional report for the term report. • The student presents the term project in class.
Learning material type	Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.
Resources and references	A- Required book(s), assigned reading and audio-visuals: 1. Richard S. Sutton, Andrew G. Barto, Reinforcement Learning: An Introduction, Second Edition, MIT Press, 2018 2. Nimish Sanghi, Deep Reinforcement Learning with Python: With PyTorch, TensorFlow and OpenAI Gym, Apress, 2021 3. Li, Yuxi, Deep reinforcement learning, arXiv preprint arXiv:1810.06339, 2018. B- Recommended book(s), material and media: 4. Reinforcement Learning, YouTube series, https://www.youtube.com/playlist?list=PLoROMvodv4rOSOPzutgyCTapiGIY2Nd8u
Topic outline and schedule	<table><tr><th>Week</th><th>Topic</th><th>ILO</th><th>Resources</th></tr><tr><td>1</td><td>Introduction to RL and Sequential Decision Making</td><td>1</td><td>1, 2,</td></tr><tr><td>2-3</td><td>Defining RL Framework and Markov Decision Process (Polices, Value Functions and Bellman Equations Exploration vs. Exploitation)</td><td>1, 2, 4</td><td>1, 2,3</td></tr></table>

4-5	Tabular Models (Monte Carlo, Dynamic Programming, and Temporal Difference models)	1, 2, 4	1
6	Libraries Used in RL	1, 2, 4	1, 2
7-8	Deep Q Networks	1, 2, 4	2
9-10	RL with Function Approximation Using Value Function Approximation (VFA)	1, 2, 4	1, 2, 3
11-12	Policy-Based Methods (Policy Gradient, REINFORCE)	1, 2, 4	2
13-14	Integrated Planning and Learning (Model Based RL, Exploration *vs*. Exploitation)	1, 2, 4	2
15	Advanced Topics: Imitation Learning, Meta Learning, and Multi-Agent Learning	1, 2, 4	1, 2, 3
16	Term Project Presentations	1, 3, 4	1, 2, 3

Evaluation tools

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:

Assessment tool	Mark	Topic(s)	Time
Homework assignments	10%	Programming aspects	W2-W14
Midterm exam	30%	Introduction through deep Q Networks	W8
Term project report and presentation	20%	Practical and presentation aspects	W15
Final exam	40%	All material	W16
Total	**100%**		

Student requirements

The student should have a computer and internet connection.

Course policies

A- Attendance policies:

- Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard.

B- Absences from exams and not submitting assignments on time:

- A makeup exam can be arranged for students with acceptable absence causes.
- Assignments submitted late, but before announcing or discussing the solution can be accepted with 25% penalty.
- The project report must be handed in in time.

C- Health and safety procedures:

- All health and safety procedures of the university and the school should be followed.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

- Open-book exams
- All submitted work must be of the submitting student.

	• Other text or code must be properly quoted with clear source specification. • Cheating will not be tolerated. E- Available university services that support achievement in the course: • Microsoft Teams team and Moodle course page • AI Lab for practicing the practical aspects and solving the programming assignments. • Program announcements Facebook group
Additional information	None

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Appendix

Learning Outcomes for the MSc in Artificial Intelligence and Robotics

Students who successfully complete the MSc in Artificial Intelligence and Robotics (AIR) will be able to:

1. Demonstrate a sound understanding of the main areas of AIR including artificial neural networks, machine learning, data science, industrial and service robots, and intelligent and autonomous robots.
2. Apply a critical understanding of essential concepts, principles and practices of AIR, and critically evaluate tools, techniques and results using structured arguments based on subject knowledge.
3. Apply the methods and techniques of the AIR fields in the design, analysis and deployment of AIR solutions and solving practical problems.
4. Demonstrate the ability to produce a substantial piece of research work from problem inception to implementation, documentation and presentation.
5. Demonstrate life-long learning, independent self-learning and continuous professional development skills in the AIR fields.
6. Demonstrate a sound understanding of the ethical, safety and social impact issues of AIR solutions and products.