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

Study plan No.	**2025/2026**		**University Specialization**		Data Science and Artificial Intelligence	
Course No.	0135343		**Course name**		Smart Mobile Robotics	
Credit Hours	**3**		**Prerequisite Co-requisite**			
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	
Akram Fatayer	Associate professor	9354	0791420797	a.fatayer@zuj.edu.jo	
Division number	**Time**	**Place**	**Number of students**	**Teaching style**	**Approved model**

Brief description

This course introduces Data Science and Artificial Intelligence students to foundational robotics, focusing on the integration of perception, planning, and control systems. The curriculum is designed following the **20/80 principle**: students learn the **critical 20% of foundational concepts** that enable them to achieve **80% of functional capability** in building intelligent robotic systems. Through carefully selected topics—computer vision for perception, A* for path planning, and PID control for motion—students gain the essential knowledge needed to integrate complete autonomous systems. The course emphasizes **project-based learning** where students implement and combine these core algorithms using Python and PyBullet simulation. The course prepares Data Science and AI students for **real-world robotics applications** by teaching them how to program, integrate, and analyze the software intelligence that drives autonomous robots, providing them with the foundational keys to explore advanced topics independently in the future

Learning resources

Course book information (Title, author, date of issue, publisher ... etc)	**1-** Siegwart, R., Nourbakhsh, I. R., & Scaramuzza, D. *Introduction to Autonomous Mobile Robots* (2nd ed., 2011), MIT Press **2-** Thrun, S., Burgard, W., & Fox, D. *Probabilistic Robotics* (2005), MIT Press
Supportive learning resources (Books, databases, periodicals, software, applications, others)	- Lab Handouts: Custom lab manuals developed by Dr. Fatayer covering: • Lab 1: Introduction to Robotics & PyBullet Setup • Lab 2: Object Detection and Computer Vision

	• Lab 3: Robot Localization • Lab 4: Environment Mapping • Lab 5: Path Planning (A* Algorithm) • Lab 6: Motion Planning & Trajectory Generation • Lab 7: Control Systems (PID & Pure Pursuit) • Lab 8: Computer Vision for Robotics & Integration - PyBullet Documentation and Tutorials - OpenCV Python Documentation - NumPy and Matplotlib Documentation			
Supporting websites	- PyBullet: https://pybullet.org/ - OpenCV: https://opencv.org/ - Python Robotics: https://pythonrobotics.readthedocs.io/			
The physical environment for teaching	√ Class room	√ labs	√ Virtual educational platform	☐ Others
Necessary equipment and software	Python 3.11, PyBullet, OpenCV, NumPy, Matplotlib- Conda environment manager- Computer with GPU support (recommended)			
Supporting people with special needs	Accessible lab facilities, screen readers compatible code editors			
For technical support	IT department support for software installation and troubleshooting			

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

No.	Course learning outcomes	The associated program learning output code
	Knowledge	
K1	Understand the fundamentals of robotics systems including the Sense-Plan-Act paradigm, sensors, actuators, and robot architectures.	MK1
K2	Explain robot perception techniques including object detection, localization, and environment mapping using computer vision.	MK2
K3	Describe path planning algorithms (A*) and motion planning strategies for autonomous navigation.	MK2
K4	Recognize feedback control systems (PID, Pure Pursuit) and their mathematical foundations for robot motion control.	MK2
	Skills	
S1	Implement robotics algorithms using Python, PyBullet, OpenCV, and related libraries to build functional robotic systems.	MK1
S2	Apply computer vision techniques (color detection, feature extraction) for robot perception and object tracking.	MS2
S3	Design and simulate autonomous robot systems that integrate perception, planning, and control modules.	MS2
	Competences	

C1	Solve real-world problems by applying robotics techniques to autonomous navigation and manipulation tasks.	MC1
C2	Analyze and evaluate the performance of different robotics algorithms and select appropriate methods for specific applications using critical thinking.	MC2

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)
PBL	0	10%	%20	**15%**
Second / midterm exam	%30	%30	%20	**%30**
Participation / practical applications/Quizzes	0	10%	10	**15%**
Asynchronous interactive activities	%30	%10	0	**0**
final exam	%40	%40	%50	**40%**

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	Introduction to Robotics - Part 1: What is a Robot, Sense-Plan-Act Paradigm	Lecture	Textbook Ch. 1, Lab 1 Handout
2	Introduction to Robotics - Part 2: Sensors, Actuators, Robot Types	Lecture + Lab	Textbook Ch. 1-2, Lab 1 Handout
3	Object Detection - Part 1: Color Spaces (RGB, HSV), Thresholding	Lecture + Lab	OpenCV Tutorials, Lab 2 Handout
4	Object Detection - Part 2: Morphological Operations, Contour Detection, Centroid Calculation	Lecture + Lab	OpenCV Tutorials, Lab 2 Handout
5	Localization - Part 1: The Localization Problem, Odometry, Dead Reckoning	Lecture	Textbook Ch. 5, Lab 3 Handout
6	Localization - Part 2: Sensor Fusion, Drift Correction	Lecture + Lab	Textbook Ch. 5, Lab 3 Handout
7	Mapping: Occupancy Grids, Grid Representation, Coordinate	Lecture + Lab	Textbook Ch. 4, Lab 4 Handout

	Conversion		
8	PBL Discussion Session 1: Project Proposal Presentations & Feedback	Project-Based Learning	PBL Guidelines
9	Path Planning - Part 1: Graph Search, A* Algorithm, Heuristics	Lecture	Textbook Ch. 6, Lab 5 Handout
10	Path Planning - Part 2: Admissibility, Optimality, Grid-Based Planning	Lecture + Lab	Textbook Ch. 6, Lab 5 Handout
11	Motion Planning - Part 1: Path vs. Trajectory, Waypoint Following	Lecture	Textbook Ch. 6, Lab 6 Handout
12	Motion Planning - Part 2: Motion Constraints, Kinematic Models	Lecture + Lab	Textbook Ch. 3, Lab 6 Handout
13	Control Systems - Part 1: PID Control, Proportional-Integral-Derivative Terms	Lecture	Textbook Ch. 11, Lab 7 Handout
14	Control Systems - Part 2: Pure Pursuit, Path Tracking, Tuning	Lecture + Lab	Textbook Ch. 11, Lab 7 Handout
15	PBL Discussion Session 2: Final Project Presentations & Demonstrations	Project-Based Learning	PBL Guidelines
16	Final Paper Exam	Exam	Course Summary, Formula Shee

*** 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.**

Schedule of asynchronous interactive activities (in the case of e-learning and blended learning)

Week	Task / activity	Reference	Expected results
1	Introduction to Robotics: Watch video on robot applications, complete quiz	Video + Quiz	To show understanding of robotics fundamentals
2	Environment Setup: Install Python environment (Conda, PyBullet, OpenCV)	Lab 1 Handout	To prepare development environment
3	Object Detection concepts: Study color spaces and thresholding	Lab 2 Handout	To understand image processing fundamentals
4	Object Detection Lab: Implement color-based object detection	Lab 2 Handout	To apply CV techniques

5	Localization concepts: Solve odometry calculation problems	Lab 3 Handout	To understand position estimation
6	Localization Lab: Implement odometry-based localization	Lab 3 Handout	To implement localization algorithms
7	**Midterm**		
8	PBL Discussion + Mapping Lab: Create occupancy grid	Lab 4 Handout	To receive feedback and refine project plan
9	Path Planning concepts: Trace A* algorithm execution	Lab 5 Handout	To understand search algorithms
10	PBL Progress Report 1: Submit implementation progress	PBL Guidelines	To demonstrate initial implementation
11	Motion Planning: Analyze trajectory generation methods	Lab 6 Handout	To understand paths vs. trajectories
12	PBL Progress Report 2: Integration testing and debugging	PBL Guidelines	To show system integration
13	Control Lab: Study PID control theory	Lab 7 Handout	To understand control fundamentals
14	PBL Final Implementation: Complete project and prepare presentation	PBL Guidelines	To finalize project deliverables
15	PBL Final Presentation & Demo	PBL Guidelines	To demonstrate complete working system
16	Final Paper Exam	Course materials	