Mohamed bin Zayed University of Artificial Intelligence

VIEWING COURSE

STATE: DIVISION REVIEW
24/8/2026

Motion Planning and Control in the Age of AI

Version: V1

ROB8501

Applies: 2026/27 Fall -

Credit Hours : 4

ROB - Robotics - Computing and Mathematical Sciences Division

PROPOSER NAME:	PROPOSED DATE:	APPROVED DATE:
Abdalla Swikir	6/7/2026	

PROPOSAL TYPE

PROPOSAL TYPE *

- [x] New course. Propose a course that has never been offered before.
- [ ] Amendment. Propose an updated version of this existing course. NB: the existing course should NOT be discontinued - it will remain in CMS as an older version.
- [ ] Discontinuation. Propose to discontinue this course and withdraw it from course offerings..

RATIONALE FOR INTRODUCTION OF NEW COURSE *

The course is introduced to address the growing need for advanced robotics education that integrates classical motion planning and control with modern AI methods. As robotic systems become more autonomous, adaptive, and safety-critical, PhD students need strong foundations in planning, control, learning-based methods, uncertainty, and responsible deployment.

The course meets students' educational needs by developing research-level skills in algorithm analysis, method design, implementation, benchmarking, and reproducible experimentation. It also aligns with industry demand for experts who can build reliable AI-enabled robotic systems for automation, mobility, manipulation, multi-robot coordination, and autonomous decision-making.

Students completing the course will gain valuable skills for careers in robotics research, academia, autonomous systems, industrial automation, AI-enabled robotics, and safety-critical control.

REGISTRATION

COURSE CODE

ROB8501

SELECT THE PROGRAM TYPE THIS COURSE WILL BE USED IN *

- [ ] Bachelor
- [ ] Graduate Diploma
- [ ] Masters
- [x] PhD

SELECT THE COURSE TEMPLATE TO APPLY *

- [x] Lecture/Lab Course
- [ ] Internship
- [ ] Research Methods Course

PRIMARY FACULTY MEMBER *

List the faculty member with primary responsibility for this course. For office hours, please advise the availability and a regular weekly office hour schedule for the students to meet with you as required (For example, Day1: HH-HH, Day 2 HH-HH, .. etc.).

NAME	EMAIL	OFFICE HOURS	PHONE	LOCATION
Abdalla Swikir				

	abdalla.swikir@mbzuai.ac.ae			

IS THE PRIMARY FACULTY MEMBER ABOVE THE COURSE COORDINATOR OF THE COURSE? *

- [x] Yes
- [ ] No

SECONDARY FACULTY MEMBER(S)

List ALL other faculty members who will teach on this course, one faculty member per row. If none, select "Not applicable" from the list. For office hours, please advise the availability in this format (Day1: HH-HH, Day 2 HH-HH, .. etc.).

NAME	EMAIL	OFFICE HOURS	PHONE	LOCATION

CATALOG IMAGE



DESCRIPTION

CATALOG DESCRIPTION *

This is a PhD-level robotics course on the theory, implementation, and research frontiers of autonomous robot planning and control. The course covers configuration-space and state-space representations, graph search, sampling-based planning, trajectory optimization, kinodynamic planning, feedback control, model predictive control, planning under uncertainty, task and motion planning, multi-robot planning, and safety-critical autonomy. It also examines how modern AI methods—learned heuristics, imitation learning, offline reinforcement learning, diffusion policies, large language models, vision-language models, and vision-language-action policies—are changing robotic planning and control. Students analyze theoretical guarantees, implement algorithms in robotics software environments, evaluate methods through reproducible experiments, and complete a PhD-level research project. Emphasis is placed on critical inquiry, methodological rigor, responsible AI, safety, reproducibility, and the ability to formulate original research questions for real-world robotic systems.

Words Remaining: **76**

GOAL

This PhD course aims to develop a deep understanding of advanced motion planning and control methods for autonomous robotic systems, with particular emphasis on how AI is transforming classical algorithmic robotics. Students will learn to analyze, design, implement, and evaluate planning and control algorithms for complex robotic problems involving uncertainty, dynamics, constraints, multi-agent interaction, semantic reasoning, and real-world execution. The course aims to prepare students to conduct original research at the frontier of robotics by combining mathematical analysis, software implementation, experimental evaluation, and critical engagement with the literature. By the end of the course, students should be capable of developing defensible research questions, proposing new methods or system integrations, benchmarking against appropriate baselines, and assessing the safety, ethical, and societal implications of AI-enabled robotic autonomy.

Words Remaining: **75**

CONTENT *

The course will cover:

- Configuration-space and state-space representations for robotic planning.
- Collision checking, cost maps, constraints, and planning representations.
- Heuristic graph search, incremental replanning, and anytime planning.
- Sampling-based planning, including PRM, RRT, RRT*, and optimal variants.
- Kinodynamic planning for robots with motion and control constraints.
- Trajectory optimization and model predictive control.
- Safety-critical control, including control barrier functions and runtime safety filters.
- Planning under uncertainty, belief-space planning, and risk-aware decision-making.
- Task planning, task and motion planning, execution monitoring, and recovery.

- Multi-robot path planning and decentralized collision avoidance.
- AI-enabled planning and control, including learned heuristics, imitation learning, diffusion policies, LLM/VLM-assisted task planning, and vision-language-action policies.
- Reproducible implementation, benchmarking, simulation, and research project development.

Words Remaining: **101**

Requisites

ASSUMED KNOWLEDGE *

Students are expected to have graduate-level knowledge of robotics, linear algebra, calculus, probability, optimization, algorithms, programming, and basic machine learning. Students should also have prior exposure to robot kinematics, dynamics, control, and robotics software tools such as ROS/Gazebo or equivalent simulation environments.

PREREQUISITE COURSE(S) *

- **ROB701 Introduction to Robotics**, or equivalent.
- **ML8101 Foundations of Machine Learning**, or equivalent.

Students who have not completed these courses may enroll with instructor approval if they can demonstrate equivalent preparation through prior coursework, research experience, or professional experience.

PLACEMENT RESULTS REQUIREMENTS *

- [x] N/A
- [ ] Passing is a prerequisite for this course
- [ ] Failing requires enrolling in the below corequisite course(s)

COREQUISITE COURSE(S) *

N/A

ANTIREQUISITE COURSE(S)

N/A

CORE (MANDATORY) COURSE FOR *

N/A

ELECTIVE COURSE FOR *

PHDROB - Doctor of Philosophy in Robotics

ARE THERE PRESCRIBED TEXTS *

- [x] Yes
- [ ] No

PRESCRIBED TEXTS *



Planning Algorithms
Steven M. LaValle

Planning algorithms are impacting technical disciplines and industries around the world, including r...

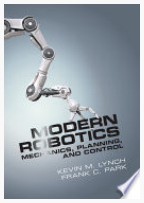
0521862051



Principles of Robot Motion
Howie Choset; Kevin M. Lynch; Seth Hutchinson; George A. Kantor; Wolfram Burgard

A text that makes the mathematical underpinnings of robot motion accessible and relates low-level de...

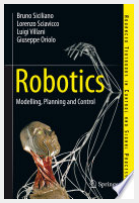
0262033275



Modern Robotics
Kevin M. Lynch; Frank C. Park

A modern and unified treatment of the mechanics, planning, and control of robots, suitable for a fir...

9781107156302



Robotics
Bruno Siciliano; Lorenzo Sciavicco; Luigi Villani; Giuseppe Oriolo

Based on the successful Modelling and Control of Robot Manipulators by Sciavicco and Siciliano (Spri...

9781846286414

ARE THERE RECOMMENDED REFERENCES & SUPPLEMENTAL MATERIAL? *

- [x] Yes
- [ ] No

RECOMMENDED REFERENCES & SUPPLEMENTAL MATERIAL *

Use this table for book and non-book references , such as articles, journals, etc., which will support student learning during the course.

ID	DESCRIPTION/REFERENCE
1	Lydia E. Kavraki, Petr Švestka, Jean-Claude Latombe, and Mark H. Overmars, "Probabilistic Roadmaps for Path Planning in High-Dimensional Configuration Spaces," *IEEE Transactions on Robotics and Automation*, 12(4), 566–580, 1996. DOI: 10.1109/70.508439.
2	Sertac Karaman and Emilio Frazzoli, "Sampling-based Algorithms for Optimal Motion Planning," *The International Journal of Robotics Research*, 30(7), 846–894, 2011. DOI: 10.1177/0278364911406761.
3	Sven Koenig and Maxim Likhachev, "D* Lite," *Proceedings of the AAAI Conference on Artificial Intelligence*, 476–483, 2002. DOI: not assigned.
4	Matthew Zucker, Nathan Ratliff, Anca D. Dragan, Mihail Pivtoraiko, Matthew Klingensmith, Christopher M. Dellin, J. Andrew Bagnell, and Siddhartha S. Srinivasa, "CHOMP: Covariant Hamiltonian Optimization for Motion Planning," *The International Journal of Robotics Research*, 32(9–10), 1164–1193, 2013. DOI: 10.1177/0278364913488805.

5	Mrinal Kalakrishnan, Sachin Chitta, Evangelos Theodorou, Peter Pastor, and Stefan Schaal, "STOMP: Stochastic Trajectory Optimization for Motion Planning," *IEEE International Conference on Robotics and Automation*, 2011. DOI: 10.1109/ICRA.2011.5980280.
6	John Schulman, Yan Duan, Jonathan Ho, Alex Lee, Ibrahim Awwal, Henry Bradlow, Jia Pan, Sachin Patil, Ken Goldberg, and Pieter Abbeel, "Motion Planning with Sequential Convex Optimization and Convex Collision Checking," *The International Journal of Robotics Research*, 33(9), 1251–1270, 2014. DOI: 10.1177/0278364914528132.
7	Maria Fox and Derek Long, "PDDL2.1: An Extension to PDDL for Expressing Temporal Planning Domains," *Journal of Artificial Intelligence Research*, 20, 61–124, 2003. DOI: 10.1613/jair.1129.
8	Hanna Kurniawati, David Hsu, and Wee Sun Lee, "SARSOP: Efficient Point-Based POMDP Planning by Approximating Optimally Reachable Belief Spaces," *Robotics: Science and Systems IV*, 2008.
9	Aaron D. Ames, Xiangru Xu, Jessy W. Grizzle, and Paulo Tabuada, "Control Barrier Function Based Quadratic Programs for Safety Critical Systems," *IEEE Transactions on Automatic Control*, 62(8), 3861–3876, 2017. DOI: 10.1109/TAC.2016.2638961.
10	Jur van den Berg, Stephen J. Guy, Ming Lin, and Dinesh Manocha, "Reciprocal n-Body Collision Avoidance," in *Robotics Research: The 14th International Symposium ISRR*, Springer Tracts in Advanced Robotics, 2011, pp. 3–19. DOI: 10.1007/978-3-642-19457-3_1.
11	Zhigen Zhao, Shuo Cheng, Yan Ding, Ziyi Zhou, Shiqi Zhang, Danfei Xu, and Ye Zhao, "A Survey of Optimization-based Task and Motion Planning: From Classical to Learning Approaches," arXiv:2404.02817, 2024.
12	Cheng Chi, Zhenjia Xu, Siyuan Feng, Eric Cousineau, Yilun Du, Benjamin Burchfiel, Russ Tedrake, and Shuran Song, "Diffusion Policy: Visuomotor Policy Learning via Action Diffusion," *The International Journal of Robotics Research*, 2024. DOI: 10.1177/02783649241273668.
13	Anthony Brohan et al., "RT-2: Vision-Language-Action Models Transfer Web Knowledge to Robotic Control," arXiv:2307.15818, 2023.
14	Moo Jin Kim et al., "OpenVLA: An Open-Source Vision-Language-Action Model," *Proceedings of Machine Learning Research*, Vol. 270, 2679–2713, 2025; arXiv:2406.09246.
15	Octo Model Team, "Octo: An Open-Source Generalist Robot Policy," arXiv:2405.12213, 2024.

LIBRARY COURSE MATERIALS

Use the link below to access textbooks and references held by the Library for the current and previous years/semesters.

Note: the materials for this course may not be available.

MBZUAI Course Materials: Home

ARE THERE RECOMMENDED TOOLS OR SOFTWARE REQUIRED? *

- [ ] Yes
- [x] No

RECOMMENDED TOOLS OR SOFTWARE

There are no recommended tools or programs for this course

TEACHING AND ASSESSMENT

Use the table below to define the **Course Learning Outcomes (CLOs)** and map each outcome to the relevant skill(s). A course will normally include **four to six CLOs**. Each CLO should begin with a measurable action verb appropriate to the course and qualification level.

The Ministry of Higher Education and Scientific Research (**MoHESR**) requires each course to identify the skill(s) developed through its CLOs. For each CLO, **select one or more relevant graduate skills, or leave the field blank** where no direct alignment applies. The graduate-skill definitions and level-specific application descriptors are provided below for reference.

COURSE LEARNING OUTCOMES (CLOS) *

On successful completion of this course, students will be able to:

CLO #	OUTCOME	PH.D. SKILL(S)
1	Critically analyze classical and AI-enabled robotic planning and control algorithms, including search-based planning, sampling-based planning, trajectory optimization, task planning, planning under uncertainty, multi-robot planning, and learning-based control.	• Original Critical Inquiry & Knowledge Creation • Deep Domain Expertise & Thought Leadership
2	Design and justify planning and control representations for robotic systems, including configuration spaces, state spaces, belief spaces, cost maps, task/action models, constraints, semantic maps, and learned representations.	• Advanced Research Design & Methodological Innovation • Complex Systems & Frontier Problem Solving
3	Analyze theoretical and practical properties of planning and control methods, including completeness, optimality, convergence, stability, robustness, safety, scalability, and computational complexity.	• Advanced Research Design & Methodological Innovation • Deep Domain Expertise & Thought Leadership
4	Implement, integrate, benchmark, and evaluate planning and control methods in reproducible robotics software environments, including simulation and, where available, real robotic platforms.	• Complex Systems & Frontier Problem Solving • Ethical Stewardship & Societal Impact
5	Formulate original research questions, develop or evaluate AI-enabled robotic autonomy methods, communicate research contributions, and apply ethical, safety, reproducibility, and societal-impact principles.	• Original Critical Inquiry & Knowledge Creation • Advanced Research Design & Methodological Innovation • Research Leadership, Collaboration & Knowledge Transfer • Ethical Stewardship & Societal Impact

GRADUATE SKILLS & LEVEL-SPECIFIC APPLICATION DESCRIPTORS

MASTER'S SKILL	APPLICATION (NQF EMIRATES LEVEL 7)	PH.D. SKILL	APPLICATION (NQF EMIRATES LEVEL 8)
Strategic Critical Thinking & Decision-Making	Analyze complex, ambiguous problems; evaluate competing evidence; make defensible, context-aware decisions	**Original Critical Inquiry & Knowledge Creation**	Formulate novel research questions; challenge existing paradigms; generate new knowledge
Advanced Research & Analytical Methods	Design and execute structured inquiry (quantitative, qualitative, computational); interpret evidence rigorously	**Advanced Research Design & Methodological Innovation**	Develop new methods, frameworks, or analytical approaches; operate at the methodological frontier
AI, Data & Digital Systems Application	Apply AI/data tools within a domain; evaluate outputs; understand limitations and risks	**Deep Domain Expertise & Thought Leadership**	Command of field literature; shape discourse; define research agendas
	Integrate knowledge across disciplines to solve complex real-world problems		Address large-scale, multi-variable problems (e.g., AI systems, climate, policy, healthcare)

System Thinking & Transdisciplinary Integration		**Complex Systems & Frontier Problem Solving**	
Leadership, Collaboration & Influence	Lead teams/projects; influence stakeholders; operate across organizational boundaries	**Research Leadership, Collaboration & Knowledge Transfer**	Lead research teams; secure funding; collaborate internationally; translate research into impact
Ethical & Responsible Professional Practice	Apply ethical frameworks in decision-making (AI, data, sustainability, societal impact)	**Ethical Stewardship & Societal Impact**	Ensure integrity, reproducibility, and responsible innovation; assess societal implications

TEACHING AND LEARNING METHODOLOGIES *

The course will be taught through a wide range of methodologies including, but not limited to, in-class lectures, group discussions, project work, laboratory exercises, presentations, problem solving sessions, and in-class or laboratory assignments. The course is assigned a course site in the MBZUAI Learning Management System (LMS), Moodle. The course site allows instructors to post static and interactive content, create assignments and implement other teaching and learning tools.

The typical structure of the course consists of two lectures per week, supplemented by a weekly tutorial or laboratory session. Faculty utilize the lecture time to present the subject material and hold class discussions, while the laboratory sessions allow students the opportunity to work individually or in small teams in conducting activities relevant to the course subject. Tutorials feature hands-on exercises and application of knowledge on practice-based problems.

TEACHING PLAN OVERVIEW *

The course will be delivered through 2 lectures of 1.5 hours each and 1 laboratory session of 2 hours per week.

During the lectures, the lecturer will introduce a topic in detail, engage students in interactive discussions, and show demonstrations (where relevant) to reinforce the lecture content. The lecturer will also provide lecture-notes, handouts, and references to reading material, where necessary.

The laboratory session will be supervised by the lecturer or the tutors. Students will use this session for problem solving, seeking clarification on the assignment work, and do implementations. During the lab time, students will be provided with a set of problems, and will be required to solve them. The supervisors will guide students with queries, questions, ambiguities, but they will not provide a solution to the problems. The lab sessions will be in a facility equipped with all the necessary software tools and hardware setups to enable students to do the coursework, including the assignment work.

Weekly topics may be varied at the discretion of the faculty to facilitate good learning and class pacing; and/or focus on emerging areas of interest or research.

TEACHING PLAN DETAILS (LECTURE/LAB COURSE) *

Click + ADD TEACHING PLAN DETAILS (LECTURE/LAB COURSE) to add the number of teaching weeks required. For each week insert a content title, lecture details, lab details, **assessment tasks due** (if any) and CLO mapping. Additionally, if required, expand to add any other relevant information.

/

1 Course Introduction and Foundations of Planning and Control in the Age of AI

LECTURE *

Lecture 1: Course overview; motion planning, control, learning, and autonomy stacks in modern robotics. **Lecture 2:**Mathematical preliminaries: configuration spaces, state spaces, robot models, metrics, constraints, and collision models.

LAB *

Robotics software setup; simulation environment setup; baseline planner and controller demonstration; reproducibility checklist.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
2, 4	Medium
5	Low

CONTRACT

OTHER INFORMATION

2 Planning Representations

LECTURE *

Lecture 1: Configuration spaces, state spaces, grids, graphs, roadmaps, cost maps, signed distance fields, and constraint representations. **Lecture 2:** Task/action models, belief states, semantic maps, learned representations, and representation failure modes.

LAB *

Implement collision checking and a 2D configuration-space visualizer; analyze discretization and representation error.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
2	High
3, 4	Medium

CONTRACT

OTHER INFORMATION

3 Heuristic Search and Replanning

LECTURE *

Lecture 1: Graph search methods: BFS, Dijkstra, A*, weighted A*, admissibility, consistency, and complexity. **Lecture 2:** Incremental and anytime replanning: D*, D* Lite, ARA*, LPA*, heuristic design, and dynamic environments.

LAB *

Implement A* and D* Lite on occupancy grids; benchmark path quality, replanning time, and heuristic behavior.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
1	High
3 4	Medium

CONTRACT

OTHER INFORMATION

4 Sampling-Based Planning

LECTURE *

Lecture 1: PRM, RRT, nearest-neighbor search, collision checking, narrow passages, and probabilistic completeness. **Lecture 2:** RRT*, PRM*, BIT*, FMT*, informed sampling, asymptotic optimality, and anytime behavior.

LAB *

Benchmark sampling-based planners in simulation; compare runtime, path quality, robustness, and success rate.

ASSESSEMENT ITEMS

Project Checkpoint 1 due: Proposal, problem formulation, and literature positioning.

CLO MAPPING *

CLO	WEIGHTING
1	High
4 3	Medium

CONTRACT

OTHER INFORMATION

5 Kinodynamic Planning and Feedback Motion Planning

LECTURE *

Lecture 1: Kinodynamic planning for systems with differential constraints; nonholonomic robots; controllability and steering functions. **Lecture 2:** Feedback motion planning, vector fields, navigation functions, funnels, tracking controllers, and local-to-global planning.

LAB *

Implement a kinodynamic planner and tracking controller for a mobile robot, manipulator, or aerial robot in simulation.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
3 4	High
1	Medium

CONTRACT ▲

OTHER INFORMATION

6 Trajectory Optimization

LECTURE *

Lecture 1: CHOMP, STOMP, smoothness costs, obstacle costs, functional gradients, and local minima. **Lecture 2:** Direct collocation, iLQR, DDP, sequential convex programming, and differentiable planning layers.

LAB *

Implement trajectory optimization with smoothness and obstacle-avoidance penalties; compare against sampling-based plans.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
1, 3, 4	High

CONTRACT ▲

OTHER INFORMATION

7 Model Predictive Control and Learning-Based Control

LECTURE *

Lecture 1: LQR, nonlinear control, operational-space control, trajectory tracking, and differential flatness. **Lecture 2:**Model predictive control, MPPI, learning-based MPC, model uncertainty, and sim-to-real issues.

LAB *

Implement MPC or MPPI for trajectory tracking and disturbance handling in simulation.

ASSESSMENT ITEMS

Project Checkpoint 2 due: Method design, system architecture, and initial prototype.

CLO MAPPING *

CLO	WEIGHTING
3, 4	High
5	Medium

CONTRACT

OTHER INFORMATION

8 Safety-Critical Planning and Control

LECTURE *

Lecture 1: Lyapunov methods, reachability, control barrier functions, CLF-CBF-QP methods, and runtime safety filters. **Lecture 2:** Safe autonomy architectures, fallback policies, safety-performance tradeoffs, monitoring, and verification assumptions.

LAB *

Implement a control barrier function or safety-filter layer for a planner/controller; evaluate safety and performance tradeoffs.

ASSESSMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
3, 5	High

4	Medium

CONTRACT

OTHER INFORMATION

9 Planning Under Uncertainty

LECTURE *

Lecture 1: MDPs, POMDPs, belief states, observation models, value functions, and information states. **Lecture 2:** Active perception, robust planning, stochastic MPC, chance constraints, and risk-sensitive planning.

LAB *

Belief-space navigation or object-search lab using particle belief updates, uncertainty propagation, and replanning.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
3	High
2, 4	Medium

CONTRACT

OTHER INFORMATION

10 Task Planning and Task-and-Motion Planning

LECTURE *

Lecture 1: STRIPS, PDDL, temporal/numeric planning, hierarchical task networks, and symbolic abstractions. **Lecture 2:** Task and motion planning, symbolic-geometric coupling, constraints, streams, behavior trees, execution monitoring, and recovery.

LAB *

Implement a task-and-motion planning scenario such as navigation-manipulation or pick-and-place with failure detection and recovery.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
1, 2, 4	High

CONTRACT

OTHER INFORMATION

11 AI-Enabled Planning and Control

LECTURE *

Lecture 1: Learned heuristics, neural cost maps, LLM/VLM-assisted task decomposition, affordance grounding, and hallucination risks. **Lecture 2:** Imitation learning, offline reinforcement learning, diffusion policies, vision-language-action policies, data curation, and generalization.

LAB *

Evaluate an AI-assisted planner or learned policy in simulation; analyze grounding, failure modes, safety constraints, and reproducibility.

ASSESSEMENT ITEMS

Project Checkpoint 3 due: Experimental evaluation, baselines, ablations, and reproducibility audit.

CLO MAPPING *

CLO	WEIGHTING
4, 5	High
1	Medium

CONTRACT

OTHER INFORMATION

12 Multi-Robot Planning and Decentralized Control

LECTURE *

Lecture 1: Multi-agent path finding, prioritized planning, conflict-based search, coupled versus decoupled planning, and scalability. **Lecture 2:** Velocity obstacles, ORCA-style methods, distributed MPC, formation control, swarm coordination, and crowd-aware navigation.

LAB *

Multi-agent simulation comparing discrete multi-agent path planning with reactive or decentralized collision-avoidance control.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
1, 4	High
3	Medium

CONTRACT

OTHER INFORMATION

13 Human-Aware Planning, Deployment, and System Integration

LECTURE *

Lecture 1: Human-aware planning, legibility, predictability, shared autonomy, human-in-the-loop planning, and interaction-aware control. **Lecture 2:** Deployment realities: perception errors, calibration, latency, compute limits, logging, fallback policies, and safety cases.

LAB *

Project integration dry run; system-level testing; safety checklist; simulation or real-robot deployment review.

ASSESSEMENT ITEMS

CLO MAPPING *

CLO	WEIGHTING
4, 5	High
3	Medium

CONTRACT

OTHER INFORMATION

14 Research Communication, Final Demonstrations, and Oral Defense

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LECTURE

Final project demos; code and reproducibility audit; final report submission; individual contribution review.

LAB *

Final project demos; code and reproducibility audit; final report submission; individual contribution review.

ASSESSEMENT ITEMS

Project Checkpoint 4 due: Final report, demonstration, reproducibility package, and oral defense.

CLO MAPPING *

CLO	WEIGHTING
4, 5	High
1	Medium

CONTRACT

OTHER INFORMATION

ASSESSMENT OVERVIEW *

Assessment is based entirely on one semester-long PhD-level research project with four checkpoints. There are no separate assignments, no laboratory portfolio assessment, no midterm, and no final exam.

The project assesses students' ability to formulate an original research problem, review relevant literature, design and implement a planning/control method, evaluate it through reproducible experiments, and communicate the results through a final report, demonstration, and oral defense.

To ensure broad engagement with the course content, each checkpoint will include a **Course Concept Coverage Table**. Students must show how their project addresses multiple core course pillars, such as planning representations, search or sampling-based planning, trajectory optimization or MPC, uncertainty, safety-critical control, task and motion planning, multi-robot planning, AI-enabled autonomy, and reproducible evaluation.

WILL THE COURSE USE THE DEFAULT GRADING SYSTEM? *

- [x] Yes
- [ ] No (I will use a modified scale)
- [ ] Pass/Fail

NOTE

The Faculty can use the approved default grading scale. If they wish to use a different scale, they can, but they must clearly indicate this in the Syllabus (by updating this grading scale). They must also update the LMS with the new scale and ensure that all students are aware of the alternative grading conversion scale.

GRADUATE DEFAULT GRADING SYSTEM

The following grades are used for this course:

GRADE	QUALITY POINTS	PERCENTAGE	GRADE DESCRIPTION
A+	4.0	90-100	Truly Exceptional Work
A	4.0	90-100	

A-	3.7	85-89.99	
B+	3.3	80-84.99	
B	3.0	70-79.99	
B-	2.7	65-69.99	
C+	2.3	60-64.99	
C	2.0	50-59.99	
F	0.0	<50	
WF	0.0	N/A	Withdrawal after the Withdrawal Deadline

GRADUATE GRADING SYSTEM POLICIES

For more information, please refer to the Grading System in the Graduate Academic Policies and Procedures.

ASSESSMENT METHODOLOGY AND CLO MAPPING *

Click + ADD ROW to add each assessment task. NB: if there are more than one of a particular assessment type, each must be entered separately, e.g. Assignment 1, Assignment 2, etc. Select Assessment Type from the list and complete the other fields.

ID	ASSESSMENT TYPE	DESCRIPTION	WEIGHTING %	WEEK(S) DUE	MAPPING TO CLO
1	Project Proposal	Define the research problem, motivation, research question, related work, expected contribution, evaluation plan, and safety/ethics considerations.	20.00%	4	1, 2, 5
2	Project Progress Presentation	Present the proposed method, system architecture, mathematical or algorithmic formulation, implementation plan, and initial prototype.	25.00%	7	2, 3, 4
3	Project Progress Presentation	Submit preliminary results, baseline comparisons, evaluation metrics, ablations, failure analysis, code documentation, and reproducibility evidence.	25.00%	11	3, 4, 5
4	Project Final Presentation	Submit the final paper-style report, code repository, experiment logs, benchmark results, demo, reproducibility checklist, and complete an oral defense.	30.00%	14	1, 4, 5

ASSESSMENT TASK AND CLO MAPPING

	1. Critically analyze classical and AI-enabled robotic planning and...	2. Design and justify planning and control representations for roboti...	3. Analyze theoretical and practical properties of planning and control...	4. Implement, integrate, benchmark, and evaluate planning and control...	5. Formulate original research questions, develop or evaluate AI-...
1	●	●			●
2		●	●	●	
3			●	●	●
4	●			●	●

COURSE POLICIES

ACADEMIC INTEGRITY

At MBZUAI, academic integrity is the cornerstone of a fair, credible, and excellence-driven educational environment. It ensures that students earn their degrees honestly, demonstrating their true knowledge, skills, and research capabilities. Upholding academic integrity is essential for:

- Promoting fairness, ensuring that all students are evaluated based on their own efforts, and fostering a culture of merit and excellence.
- Preserving the value of MBZUAI degrees, ensuring they remain respected and prestigious for current and future graduates.
- Encouraging personal and professional growth, helping students develop critical thinking, problem-solving, and ethical research skills.
- Maintaining MBZUAI's reputation as a leading AI research institution, upholding the highest academic and research standards.

Violations of academic integrity – referred to as academic misconduct – not only undermine individual learning but also compromise the university's integrity and its contributions to the field of AI. Such violations are taken seriously, as they directly challenge the principles and values MBZUAI upholds. MBZUAI has clear procedures in place to adjudicate alleged academic misconduct, as are detailed in the Academic Integrity Policy.

STUDENTS OF DETERMINATION

At MBZUAI, we are committed to treating all students with fairness, dignity, and respect. We provide an inclusive academic and campus environment where students of determination (i.e., students with disabilities or specific learning needs) can thrive.

MBZUAI does not discriminate on the basis of nationality, race, gender, religion, disability, or socioeconomic background. We welcome and support students of determination in line with UAE legislation, Ministry of Education standards, and University policies.

ALL GRADUATE ACADEMIC POLICIES

Please refer to the Graduate Academic Policies for details about Course exemptions, Course substitution, Course registration, Course withdrawal, Attendance, Student progress criteria, academic standing requirements, Student scholarship and support, and Graduation requirements.

CURRICULUM MAP

A Curriculum Map must be created in the Mapping Section to show the relationship of the Course Learning Outcomes of this course to the Program Learning Outcomes of each Program where this Course can be taken.

This Map is to be created in the Mapping Section with the help of CTL team (ctl@mbzuai.ac.ae) and then a link to the map to be inserted in below.

LINK TO MAP (OPTIONAL)

DISCONTINUATION

ADMINISTRATION