Course Specifications

Course Title:	Principles of Robot Autonomy
Course Code:	AI 425
Program:	**Information and Computer Science**
Department:	**Computer Science and Information**
College:	College of Science in Zulfi
Institution:	Majmaah University

Table of Contents

A. Course Identification

1. Credit hours:
2. Course type **a.** University ☐ College ☐ Department ☐ Others ☐ **b.** Required ☐ Elective ☒
3. Level/year at which this course is offered:
4. Pre-requisites for this course (if any)**:** • Introduction to Robotics – AI 413
5. Co-requisites for this course (if any)**:** None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	48	80%
2	**Blended**	6	10%
3	**E-learning**	6	10%
4	**Correspondence**		
5	**Other**		

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
Contact Hours		
1	**Lecture**	30
2	**Laboratory/Studio**	30
3	**Tutorial**	
4	**Others** (specify)	
	Total	60
Other Learning Hours*		
1	**Study**	30
2	**Assignments**	30
3	**Library**	20
4	**Projects/Research Essays/Theses**	20
5	**Others** (specify)	
	Total	100%

* The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

B. Course Objectives and Learning Outcomes

1. Course Description

This course will cover the basic principles for endowing mobile autonomous robots with perception, planning, and decision-making capabilities. You will learn algorithmic approaches for robot perception, localization, and simultaneous localization and mapping as well as the control of non-linear systems, learning-based control, and robot motion planning. The course will introduce methodologies for reasoning under uncertainty and will include extensive use of the Robot Operating System (ROS) for demonstrations and hands-on activities.

2. Course Main Objective

With this class, the student will:
• Gain a fundamental knowledge of the "autonomy stack" behind self-driving cars, drones, and mobile autonomous robots in general;
• Be able to apply such knowledge in applications and research work by using ROS;
• Devise novel methods and algorithms for robot autonomy

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge:**	
1.1	Understanding the different concepts regarding robotic perception, localization, and simultaneous localization and mapping (SLAM); state machines	K3-AI
1.2		
1.3		
1...		
2	**Skills :**	
2.1	Identify the different Algorithmic approaches for trajectory optimization and robot motion planning	S3-AI
2.2	Learn the methodologies for reasoning under uncertainty e.g., (partially observable) Markov decision processes	
2.3		
2...		
3	**Competence:**	
3.1	Make extensive practice of the Robot Operating System (ROS) for demonstrations	C3-AI
3.2		
3.3		
3...		

C. Course Content

No	List of Topics	Contact Hours
1	Motion control and planning : Course overview, mobile robot kinematics, Introduction to the Robot Operating System (ROS), Trajectory optimization , Trajectory tracking & closed loop control, Advanced methods for trajectory optimization , graph search methods, sampling-based methods	20
2	Robotic perception : Robotic sensors & introduction to computer vision ,Camera models & camera calibration, Image processing, feature detection & description, Information extraction & classic visual recognition, Modern robotic perception	12
3	Localization and SLAM: Introduction to localization & filtering theory Parameteric filtering (KF, EKF, UKF), Monte Carlo localization and Non parameteric filtering (PF), particle filter SLAM, Multi-sensor perception & sensor fusion	16
4	State machines, decision making, and system architecture: Software for autonomous systems, State machines, Decision making under uncertainty	12
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge**		
1.1 1.2 …	Understanding the different concepts regarding robotic perception, localization, and simultaneous localization and mapping (SLAM); state machines	Lectures. Case studies	Written Exam Homework assignments Quizzes
2.0	**Skills**		
2.1	Identify the different Algorithmic approaches for trajectory optimization and robot motion planning	Lectures. Lab Case studies. Individual presentations. Brainstorming.	Written Exam Homework assignments Lab assignments Class Activities Quizzes
2.2	Learn the methodologies for reasoning under uncertainty e.g., (partially observable) Markov decision processes		
…			
3.0	**Competence**		
3.1	Make extensive practice of the Robot Operating System (ROS) for demonstrations	Lectures. Lab Case studies. Individual group discussions. Brainstorming. Presentations	Written Exam Homework assignments Lab assignments Class Activities Quizzes
3.2			
…			

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	First written mid-term exam	6	15%
2	Second written mid-term exam 12	12	15%
3	Group Project	14	10%
4	Homework assignments	After every chapter	10%
5	Practical exam	15	10%
6	Final written exam	16	40%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

1. 6-office hours per week in the lecturer schedule.
2. The contact with students by e-mail , mobile, office telephone and website.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	• Mastering ROS for Robotics Programming, L. Joseph, J. Cacace, 2nd Edition, 2015, ISBN-10: 1788478959, 2015
Essential References Materials	R. Siegwart, I. R. Nourbakhsh, D. Scaramuzza. Introduction to Autonomous Mobile Robots. MIT Press, 2nd Edition, 2011, ISBN-10: 0262015358. Price: $38.11.
Electronic Materials	
Other Learning Materials	• J. M. O'Kane. A Gentle Introduction to ROS. 2013, ISBN-10: 1492143235. Price: $12.50. Free electronic version available at https://cse.sc.edu/~jokane/agitr/.

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	_ Class Rooms _ Computer Labs _ Library
Technology Resources (AV, data show, Smart Board, software, etc.)	Smart Board

Item	Resources
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Analysis of students' results.	Teaching Staff	Direct
Observation during work	Teaching Staff	Indirect
Students' evaluations.	Teaching Staff	Direct
Colleagues' evaluations.	Peer Reviewer	Indirect
Evaluation questionnaire filled by the students.	Students	Indirect
Interview a sample of students enrolled in the course to take their opinions.	The head of department	Indirect

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	
Reference No.	
Date	