School of Industrial Engineering Spring 2018
Purdue University

IE 574: Industrial Robotics & Flexible Assembly

Prerequisites	Graduate or Senior engineering students
Instructor	Juan P. Wachs Office hours: By BB email, W 2:30-3:30pm GRIS 262
Teaching Assistants	Glebys Gonzales (lead TA) Office hours: Th 3:00pm-4:00pm – Grissom 157- Natalia Sanchez Tamayo Office hours: T- 3:00pm-4:00pm – Grissom 157-
Lectures	MWF 12:30 pm – 1:20 pm (Lecture, Wang Hall 2579)
Text (optional)	Siciliano, Bruno, and Oussama Khatib, eds. Springer handbook of robotics. Springer Science & Business Media, 2008. Shimon Y. Nof. Handbook of Industrial Robotics, Vol. 1. John Wiley & Sons, 1999.
Website	Blackboard Learn: https://mycourses.purdue.edu
Email:	All class-related emails should be sent only via BB email to both *All Instructors and All TAs*, to prevent delay or loss by spam blockers.

COURSE OBJECTIVES

Industrial robots (as opposed to toy robots) have come a long way: Beyond manufacturing, transportation and construction, they are applied in healthcare, exploration, environmental protection and other field and service applications, with exciting and significant impact on industry and society. We will learn how to design, select and operate intelligent robots and autonomous systems, and how to plan effective implementation and application of robotic automation. Students completing the requirements of this course will acquire:

- Understand and implement key fundamental principles of robot mechatronics
- Learn IE methods/algorithms to plan robotic cells, lines, teams, swarms.
- Work with robot simulators and emulators and program them effectively.

COURSE PHILOSOPHY

Due to rapid changes of information and computing technologies, a single textbook or an instructor cannot provide sufficient depth and breadth of the topics of this class. Thus, every participant, i.e., students, instructors, and TAs of this class is highly encouraged and expected to bring in new ideas and knowledge to class. Any constructive feedback to make this class more educational and inspirational is highly welcome. To make our evolutionary course sustainable, however, certain class policies will be strictly applied.

COURSE TOPICS

Students will accomplish the following learning throughout this course:

1. Fundamental principles of robot Mechatronics;
2. Lab demos with robot and vision systems, from simple to intelligent;
3. IE methods/algorithms to plan robotic cells, lines, teams, swarms;
4. Robot simulators and emulators;

5. Robot cognition, interaction, intelligence, and social behavior;
6. Human-robot interaction; Humanoids, and biologically-inspired robots;
7. Robots & sustainability: Eco-robots; renewable energy-powered robots.

GRADING

Items	Percentage
Class participation (e.g. feedback, online assessment)	5 %
Homework and lab assignments	30 %
Project (individual- as final exam)	35 %
Mid-term exam (take home)	30 %
Total	**100 %**

CLASS POLICY

- **Reading Assignments**
  - Students are expected to finish the reading assignments before coming to a class. Reading assignments are listed in the posted class notes.
  - Students are expected to review previous lecture before coming to a class.
- **Homework**
  - Six bi-weekly homeworks, must be submitted only via BlackBoard.
  - Students must submit all homework to SafeAssign, a plagiarism detection (or an equivalent system) service available, in BlackBoard. Before submitting your homework, please remove your title page and other personal information. Any paper that is not submitted to the system will not be accepted by the instructor and will not be graded.
  - Plagiarized homework will not be graded.
  - Each student should double check whether his/her submission was completed properly. If a student runs into a BlackBoard error, he/she should proactively resolve the error through ITaP. If the error may impact other students or persist, please immediately contact the instructor and TAs to remedy the issue.
  - Homework will NEVER be accepted after the due date and time.
- **Examinations**
  - Midterm exam is a taking home exam.
  - It is forbidden to exchange/copy material from a different exam
  - Make-up examinations are limited only for documented severe medical reasons. No make-up given for other reasons, including job interviews.
- **Re-grading**
  - Requests for re-grading examinations and assignments will be considered only with a written explanation, submitted in class only to the instructor after at least 24 hours of self-evaluation, and only within ONE-WEEK from the time the graded work is returned. The final grade of requested material can increase, remain the same or decrease.
- **Final Grades**
  - Plus (+) and minus (-) grades will be used for this semester.
- **Misconduct**

- Any types of Misconduct as defined in Student Conduct (Part 5) of the University Regulations will not be tolerated: http://www.purdue.edu/univregs/studentconduct/regulations.html
- The instructors and the TAs will follow the regulations strictly.

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**"I always forget how crazy things are
so sometimes it catches me off my guard
when they make sense."**

-- Peter Hammill

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CAMPUS EMERGENCY

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Changes about the course will be announced through the BlackBoard and/or class mailing list. (See Emergency Plan for Grissom Hall below).

Emergency Plan (for Grissom Hall Personnel and Students only)

1. If building evacuation is necessary (e.g., a fire alarm), follow the exit signs and proceed to the Emergency Assembly Area. The Emergency Assembly Area for Industrial Engineering personnel is the East end of the Main Aisle of Stewart Center on the First Floor (Near the doors that go outside to the Memorial Union).

2. In the event of a tornado warning, members of Grissom Hall should proceed down the center staircase to the basement hall area. Try to stay away from the removable roof area. Anyone with a key should open Room B5 and all should take shelter in Room B5.

3. If you are directed to shelter in place, but you are unaware of the specific reason, proceed to the lowest level of the building (again Room B5 is an excellent choice) but continue to seek additional information by all possible means to determine the type of incident. Once you have determined the type of emergency, follow the below chart:

a) Weather-Related—Tornado Warning: Basement corridors, basement offices, basement restrooms Or the lowest level of the building (stay away from windows and doors)
b) Hazardous Materials (HAZMAT) Release: Remain or find an unaffected office or work area and close windows and doors.
c) Civil Disturbance—active shooter: Seek a safe location, preferable a room without windows that can be locked or secured by barriers.

The full building emergency plan can be found at

https://engineering.purdue.edu/IE/AboutUs/GrisSafety

Week	Date	Labs	Remark	Specific Topic	Read
1	8-Jan			Course Organization & intro	
	10-Jan		HW1 Posted	History and Terminology	SHBA CH 3
	12-Jan			Robot types and intro to affordability	SHBA CH 3
2	15-Jan		Martin Luther King Holiday		
	17-Jan			Affordability and intro to robot generations	HBIR CH4 & SHBA CH40
	19-Jan		Lab 1 Intro	Robot Configurations & Lab 1 Intro	CH 2
3	22-Jan			Actuators	CH 3
	24-Jan	LAB 1	Lab 1	Laboratory 1: Pick and Place (TA present)	CH 4
	26-Jan		**HW1 Due date**	Robot motion	CH 4
4	29-Jan		HW2 Posted	Kinematic Chains + Project discussion	CH 5
	31-Jan			Robot Accuracy	CH 5
	2-Feb			Homework 1 Discussion (TA present)	CH 5
5	5-Feb		**Project Report 1 Due date**	Problem solving in class	CH 6
	7-Feb	LAB 2	Feedback of Phase 1 Project	Discussion of Project Evaluation and	
	9-Feb		**HW 2 Due date**	Laboratoy 2: Offline and online programming (TA present)	CH 6
6	12-Feb		HW3 Posted	Robot programming	CH 6
	14-Feb			Discussion of Exam and Project Phase 2	CH 6
	16-Feb			Feedback Lab 2	CH 7
7	19-Feb			Robot programming II	CH 7
	21-Feb	LAB 3	**HW3 submission/ Lab 2 Due date**	Welding & Surgery (two worlds?)	
	23-Feb			Laboratory 3: Trajectory and Motion Planning (TA presenter)	CH 7
8	26-Feb			Sensor based Motion	CH 7
	29-Feb			Inhibitors	
	2-Mar		HW4 Posted / **Midterm Exam posted**	Automation Levels	
9	5-Mar			Assembly, Linkage and Intelligence	CH 8
	7-Mar		**Project Report 2 Due date**	AI and Sensors	
	9-Mar		**Midterm exam due date (midnight)**	**Vision Sensors (Machine vision)**	CH 8
	12-Mar		**Spring Vacations**		
	14-Mar		**Spring Vacations**		
	16-Mar		**Spring Vacations**		
10	19-Mar		HW 5 Posted	Laboratory 4: Collaboration & Performance	CH 10
	21-Mar	LAB 4		Review successful projects	
	23-Mar			Task planning	
11	26-Mar		HW4 Due date/ Lab 3 due date	**Task planning II**	CH 10 & 11
	28-Mar			Motion planning	
	30-Mar			Robot Controller	CH 11
12	2-Apr			Positioning on the fly and intro to ergonomics	CH 11
	4-Apr		HW5 Due date with Lab 4	Feedback HW 4 & Lab 4 feedback (TA	CH 12
	6-Apr		HW 6 Posted	Robot ergonomics	CH 11 & 12
13	9-Apr		Project presentations	Laboratory 5: Robot Welding Application	CH 12
	11-Apr	LAB 5	Project presentations	Project Presentation by RA (TA)	CH 12
	13-Apr		Project Phase 3 Due date (and files)	Project Presentation by PhD/ master	CH 12
14	16-Apr			Calibration & monitoring errors	CH 13
	18-Apr		Off-campus presentations	Presentations / Humanoids	CH 13
	20-Apr		HW6 Due date with Lab 5	Offline presentation / Feedback on HW 5	
15	23-Apr		Off-campus presentations	Presentations / Feedback on HW 6 & Lab 5	CH 13
	25-Apr			Presentations	CH 13
	27-Apr		**LAST DAY OF CLASS**	Presentations	CH 13
16	30-Apr				
	2-May				
	TBA				