



Course Title: Robotic Fabrication			
Course Number	EVDS 683.81		
Pre/Co-Requisites	n/a		
Instructor Name	Guy Gardner	Instructor Email	gegardne@ucalgary.ca
Office Location	CBDL main floor		
TA Name	Kim Tse	TA Email	Anson.tse@ucalgary.ca
Class Dates	e.g. Fall 2019, Wednesday		
Class Times	e.g. 10:40am to 1:50Pm		
Class Location	e.g. PF3176		

Course Information / Description of the Course

Industrial Robotics are poised to transform the way buildings are designed and made. The Introduction to Robotic Fabrication course is intended for students and practitioners who are interested in digital craft and the implications of industrial robotics for architectural design research and construction. Lectures and tutorials will provide participants with the basic vocabulary and safe working practices necessary to work in proximity with industrial robotics. Collaborative design and making activities leveraging computation and digital fabrication will allow participants to learn about robot programming in a hands-on manner. The course will explore the development of tools and techniques for the production of architectural prototypes. Software including Rhino, Grasshopper, RoboDK and Robotstudio will be used to control Universal UR10-E and ABB IRB2600 Industrial Robots. Students will work iteratively to develop end-of-arm tooling, toolpaths, simulations, digital outputs and other processes necessary for the production of their projects. Deliverables will include exhibition-ready 1:1 prototypes, documentation of the tools, techniques and processes developed, and speculation about the future uses for these techniques.

Learning Resources

Required readings, textbooks and learning materials:

Wit, Andrew & daas, mahesh. (2018). Towards a Robotic Architecture.

Benjamin, W. (ND). Art in the Age of Mechanical Reproduction

<http://web.mit.edu/allanmc/www/benjamin.pdf>

Pigram, Dave; McGee, W. (2011). Formation Embedded Design a methodology for the integration of fabrication constraints into architectural design. In J. Taron (Ed.), ACADIA 2011: Integration Through Computation: Proceedings of the 31st Annual Conference of the Association for Computer Aided Design in Architecture (pp. 122–131). New York.

Additional Readings TBD

Technology requirements (D2L etc.):
D2L, laptops, specialized software

Course Learning Outcomes

Objectives

1. To acquire a basic knowledge of 6 axis robotic protocols
2. To develop physical and digital tools for use in the production of surfaces and assemblies
3. To demonstrate these tools through the production of a series of robotically produced artifacts.

Assessment Components

Assessment Method	Description	Weight	Aligned Course Learning Outcome
			e.g. 1 and 3

Assessment and Evaluation Information

Students will be evaluated individually for all assignments. In the case of group assignments, participants will be asked to describe their contribution to the assignment. Projects will be evaluated for completeness, quality and originality. Work submitted late will lose 10% points per day at the discretion of the instructor.

Assignment 01: Robot Portraits (pairs)	10%	Sept. 18
Assignment 02: Pseudo Code/Diagrams (team)	10%	Oct. 2
Assignment 03: Simulation/pre-production planning (team)	15%	Oct. 16

Assignment 04: Project Presentation+Documentation(team)	50%	Dec. 4
Assignment 05: Project Speculation (individual)	15%	Dec. 15
Total	100%	

Note: Students must submit and pass Assignments 4 & 5 in order to receive credit for the course.

Registrar-scheduled Final Examination: No

Policy for Late Assignments

Assignments submitted after the deadline will be penalized with the loss of a grade (e.g.: A- to B+). For late submission after one week but not more than 2 weeks late, the loss will be two grades, e.g.: A- to B. Assignments will not be accepted after 3 weeks.

Grading Scale

Final grades will be reported as letter grades, with the final grade calculated according to the 4-point range. Assignment(s) will be evaluated by percentage grades, with their letter grade equivalents as shown.

Grading Scale				
Grade	Grade Point Value	4-Point Range	Percent	Description
A+	4.00	4.00	95-100	Outstanding - evaluated by instructor
A	4.00	3.85-4.00	90-94.99	Excellent - superior performance showing comprehensive understanding of the subject matter
A-	3.70	3.50-3.84	85-89.99	Very good performance
B+	3.30	3.15-3.49	80-84.99	Good performance
B	3.00	2.85-3.14	75-79.99	Satisfactory performance
B-	2.70	2.50-2.84	70-74.99	Minimum pass for students in the Faculty of Graduate Studies

C+	2.30	2.15-2.49	65-69.99	All final grades below B- are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements.
C	2.00	1.85-2.14	60-64.99	
C-	1.70	1.50-1.84	55-59.99	
D+	1.30	1.15-1.49	50-54.99	
D	1.00	0.50-1.14	45-49.99	
F	0.00	0-0.49	0-44.99	

A student who receives a "C+" or lower in any one course will be required to withdraw regardless of their grade point average (GPA) unless the program recommends otherwise. If the program permits the student to retake a failed course, the second grade will replace the initial grade in the calculation of the GPA, and both grades will appear on the transcript.

(for Architecture courses only) CACB Student Performance Criteria

The following CACB Student Performance Criteria will be covered in this course at a primary level (other criteria will be covered at a secondary level):

Primary:

A2: Design Skills, B11. Building Materials, Construction Techniques

Topic Areas & Detailed Class Schedule

Course Schedule Date	Topic	Assignments/Due Dates
September 11	Course Intro Designing for Robotic Fabrication: examples and approaches - Precedent projects and workflows - Resources - Previous LID and Robotic Fabrication Course projects - Assign project 1 Portrait demo (due Sept 18) - Review script and plugins. Students are to execute a robot portrait of their partner using universal robots. Project Introduction: Zoominesence	Assign project 1 Portrait demo (due Sept 18)

	<ul style="list-style-type: none"> - Project scope: 3 outdoor installations - Presentations on the design intent and potential methods for each project 	
September 18	<p>Review Assignment 1: Pinup robot portraits Form project teams Assign Reading Assign Project 2 (Pseudocode) to project teams Lecture (GG) Craft and Industry 4.0 Tutorial: (TA presentation) Robot Arm: movement and scripting basics</p> <ul style="list-style-type: none"> - Controlling robots with Grasshopper - Understanding planes and robot orientation - - Planning toolpaths, approach and retraction - Changing speeds - Digital signals - Live demo/workshop 	Assign Project 2 (Pseudocode) to project teams (due oct 2)
September 25	<p>Group Discussion Session: Reading & Techniques Tutorial: (TA presentation) Large Scale 3D printing</p> <ul style="list-style-type: none"> - Breaking down objects as toolpaths for large 3D printer - Grasshopper Plugins and Scripts for creating custom 3D print toolpaths (fills, rafts, support, etc.) continuous paths, varying speeds, additional movements - Additional tools – foam wire cutter – router/spindle – etc. - Additional tool basics: tool collision - Wire foam cutter: optimal orientation and limitations – ruled surfaces - Stationary foam cutting - Router/spindle: move speed limits and material, spindle speed limits - Securing material <p>Example scripts review Assigned reading Project Development – Teams</p>	
October 2	<p>Assignment 2: Pseudocode Student Presentations Introduce Assignment 3: Simulation Tutorial: Simulation Physical & Digital</p> <ul style="list-style-type: none"> - ABB programming, common commands 	introduce Assignment 3: Simulation , due oct 16

	- Introduction to RobotStudio	
October 9	Guest Lecture: robotic pellet extrusion Tutorial: Microcontroller programming and interfacing with GH	
October 16	Assignment 3: Simulation Student Presentations End of prototyping phase. Final desk crits for project planning (pseudocode, materials list, production plan, budget and timeline) Preparation for entering production phase.	
October 23	No classes / SAPL Block Week	
October 30	Project production	
November 6	Project production	
November 12 – 14	No classes – term break	
November 19 – 21	Projects Complete and ready for transport	
November 26 – 28	Project delivery and installation	
December 3 – 5	Exhibition review/Jury	

Indicate the following dates:

- If applicable, dates, times and locations of all approved class activities scheduled outside of regular course hours
- If applicable, dates, times, locations and referral to the student centre for unique and binding drop/withdraw deadlines for courses that have been approved to run outside of regular term dates

Media and Recording in Learning Environments

Part 1

University Calendar: <https://www.ucalgary.ca/pubs/calendar/current/e-6.html>

Recording of lectures (other than audio recordings that are pre-arranged as part of an authorized accommodation) is not permitted.

Students may not record any portion of a lecture, class discussion or course-related learning activity without the prior and explicit written permission of the course instructor or authorization from Student Accessibility Services. For any other use, whether by duplication, transcription, publication, sale or transfer of recordings, written approval must be obtained

from the instructor for the specific use proposed. Any use other than that described above constitutes academic misconduct and may result in suspension or expulsion.

Part 2

The instructor may use media recordings to capture the delivery of a lecture.

The instructor will notify all students and guests in the class that the event is being recorded. If a student or guest wants to take steps to protect privacy, and does not want to be recorded, the instructor will provide the individual (s) with an alternative means of participating and asking questions (e.g., passing written notes with questions). Students cannot be penalized for choosing not to be recorded in situations where participation is part of the course. Students must be offered other ways of earning participation credit that do not involve recording.

Any video-recording would be intended to only capture the instructor and the front of the classroom. Students/other participants would not necessarily be visible on video recordings.

Special Budgetary Requirements

nil

University of Calgary Policies and Supports

ACADEMIC ACCOMMODATION

Students seeking an accommodation based on disability or medical concerns should contact Student Accessibility Services; SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/. Students who require an accommodation in relation to their coursework based on a protected ground other than disability should communicate this need in writing to their Instructor. The full policy on Student Accommodations is available at <http://www.ucalgary.ca/policies/files/policies/student-accommodation-policy.pdf>.

ACADEMIC MISCONDUCT

Plagiarism involves submitting or presenting work in a course as if it were the student's own work done expressly for that particular course when, in fact, it is not. Most commonly plagiarism exists when: (a) the work submitted or presented was done, in whole or in part, by an individual other than the one submitting or presenting the work, (b) parts of the work are taken from another source without reference to the original author, (c) the whole work (e.g., an essay) is copied from another source, and/or, (d) a student submits or presents work in one course which has also been submitted in another course (although it may be completely original with that student) without the knowledge of or prior agreement of the instructor involved. While it is recognized that scholarly work often involves reference to the ideas, data and conclusions of other scholars, intellectual honesty requires that such references be explicitly and clearly noted. Plagiarism is an extremely serious academic

offence. Any suspicion of plagiarism will be reported to the Dean, and dealt with as per the regulations in the University of Calgary Graduate Calendar.

For information on academic misconduct and its consequences, please see the University of Calgary Calendar at <http://www.ucalgary.ca/pubs/calendar/current/k.html>

COPYRIGHT LEGISLATION:

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (www.ucalgary.ca/policies/files/policies/acceptable-use-of-material-protected-by-copyright.pdf) and requirements of the copyright act (<https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html>) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy.

FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary.

UNIVERSITY STUDENT APPEALS OFFICE: If a student has a concern about the course, academic matter, or a grade that they have been assigned, they must first communicate this concern with the instructor. If the concern cannot be resolved with the instructor, the student can proceed with an academic appeal, which normally begins with the Faculty. <https://ucalgary.ca/student-appeals/>

More student support and resources (e.g. safety and wellness) can be found here: <https://www.ucalgary.ca/registrar/registration/course-outlines>