Course Information

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E4-02-06	**Monday**			**Tuesday**			**Wednesday**			**Thursday**		
Time	9-11	12-14	15-17	9-11	12-14	15-17	9-11	12-14	15-17	9-11	12-14	15-17
Odd Wks	B01	B03	B05	B07	B09	B11	B13	B15	B17	B19	B21	B23
Even Wks	B02	B04	B06	B08	B10	B12	B14	B16	B18	B20	B22	B24
Tutor	JK	AT	SS	SZ	SZ	NC	DZ	FR	XT	DZ	FT	MC
TA	DK	DL	DL	PK	JL	JJ	PK	JL	RS	GL	JJ	GL
TA	YL	HB	AJ	FS	AJ	GT	YK	ML	HB	ML	GT	YK

Course Objectives

This module covers the fundamentals of engineering design and prototyping. Students will learn design principles and tools through lectures and engage in experiential learning through group design projects. A stage-based design process will be covered. Students will develop skills in Arduino-controlled electronics, CAD modelling, and rapid prototyping to demonstrate their ideas.

Calendar

Week #	Dates	Lecture/Assignment	Tutorial	Wk
1	15 Jan – 19 Jan	Lec: Introduction	None	
2	22 Jan – 26 Jan	Lec: Arduino 1	T1	Even
3	29 Jan – 2 Feb	Lec: Arduino 2	T1	Odd
4	5 Feb – 9 Feb	Lec: CAD 1	T2	Even
5	12 Feb – 16 Feb	Lec: CAD 2	T2	Odd*
6	19 Feb – 23 Feb	Lec: Design	T3	Even
Recess	24 Feb – 3 Mar			
7	4 Mar – 8 Mar	Arduino Quiz (8 Mar)	T3	Odd
8	11 Mar – 15 Mar	CAD Quiz (15 Mar)	T4	Even
9	18 Mar – 22 Mar		T4	Odd
10	25 Mar – 29 Mar		T5	Even†
11	1 Apr – 5 Apr		T5	Odd
12	8 Apr – 12 Apr	Paper & Video both	T6	Even⋆
13	15 Apr – 19 Apr	due at start of T6	T6	Odd

*Mon 12 Feb is Chinese New Year. Makeup sessions for B01, B03, B05 will occur in Recess Week on Mon, 26 Feb.

†Thu 28 Mar is NUS Well-Being Day. Makeup sessions for B20, B22, B24 will occur in Reading Week on Thu, 25 Apr.

⋆Wed 10 Apr is Hari Raya Puasa. Makeup sessions for B14, B16, B18 will occur in Reading Week on Wed, 24 Apr.

Assessment

EG1311 revolves primarily around a team project. Thus, assessment is divided between individual performance and the performance of your team. Detailed rubrics for how these components will be graded are provided in the following sections. **Attendance and participation in tutorial are mandatory.** If you have unexcused tutorial absences or receive extremely low peer review marks, you may be deemed ineligible to receive some or all marks awarded to your team.

Team (45%)	Percentage	Individual (55%)	Percentage
Obstacle Checkoff	10%	Arduino Quiz	15%
Report Body	10%	CAD Quiz	15%
Report Appendix	10%	Lecture Viewing	10%
Video (External Review)	10%	Peer Review (Midterm)	5%
Video (Tutor)	5%	Peer Review (Final)	10%

Software

You will be required to install two pieces of software on your laptop: the Arduino IDE (Integrated Development Environment) and Fusion 360. In addition, you will need to create an account with the online webtool TinkerCAD. You will need to use these software for your project during lab, during lecture, and during the two quiz assessments. **Please bring your laptop to every tutorial session, ready to use these software.**

Software	Purpose	Website
Ardunio IDE	Compile & Upload	`https://www.arduino.cc/en/software/`
TinkerCAD	Circuit Simulation	`https://www.tinkercad.com`
Fusion360	3D Modeling Suite	`https://www.autodesk.com/products/fusion-360`

Canvas Website: `https://canvas.nus.edu.sg/courses/53791`
TEAMMATES (for peer review) `https://teammatesv4.appspot.com/`
Optional Reference, Intro to Arduino Wiki: `https://wiki.nus.edu.sg/display/Arduino`

Lectures

EG1311 Lectures will be given during the first six weeks of term as prerecorded video lectures on Design, Arduino, and Computer-Aided Design (CAD), accessible through the Videos/Panopto Tab on Canvas. Lecture slides will be posted to Canvas in the Files section. To accommodate online viewing, we have broken up each week's lecture content into multiple smaller videos which will be posted at the beginning of each week (total video length will be less than 3 hours). Each video will be accompanied by questions that must be answered correctly before the video can be completed. To complete a video, you must finish viewing it **before 5pm on Friday in the same week the video was released**. Your lecture video completion rate will comprise 10% of your grade.

In addition to prerecorded lectures, we will hold an **optional** live and interactive Q&A session over Zoom on Fridays from 9am – 10am. There, you can ask questions about lecture content, lab content, and or general troubleshooting for your project. Viewing and participation in these sessions will not be graded. These sessions will be recorded and available on Canvas, so keep that in mind if you choose to share your video or audio during these sessions. Zoom access details can be found in the **Zoom** section of Canvas.

Quizzes

There will be two quizzes, covering Arduino (Lectures in weeks 2-3) and CAD (Lectures in weeks 4-5) respectively. Each quiz will be given online via Canvas. Each quiz will a combination of 15 multiple-choice/true-false/matching/fill-in-the-blank questions, which must be answered within **45 minutes** (questions will be randomly selected from a larger set, and order will be jumbled). Each online quiz will be open to submission for 12 hours: from 10am–10pm on Friday, in week 7 for Arudino and week 8 for CAD. Both quizzes are **open notes**: you may reference course materials and your own notes, but you **may not communicate with anyone during the quiz**. Some questions on the CAD quiz will require you to use Fusion 360 during the quiz.

Tutorials

There are 24 tutorial sections in EG1311 this term: B01 - B24. Each section meets in Rm. E4-02-06 for 2 hours, six times on alternating weeks beginning in week 2. Specifically, section BXX meets:

- on weeks 2,4,6,8,10,12 if XX is even, and
- on weeks 3,5,7,9,11,13 if XX is odd.

Note that Mon 12 Feb, Thu 28 Mar, and Wed 10 Apr are institute holidays. For sections that would normally meet on those days, a makeup tutorial session will be given on the same day of the week during either Recess or Reading Week: on Mon 24 Feb, Thu 25 Apr, and Wed 24 Apr respectively.

Each tutorial will begin promptly at the designated start time. Students must leave the lab by the end of the scheduled tutorial, and may leave early only at the discretion of your Tutor. In-person attendance at **tutorial is mandatory**, and attendance will be taken. If you cannot make your tutorial session for whatever reason, please email Dr. Ku with an explanation. If your reason is medical, you will need to obtain and send a valid Medical Certificate (MC).

The lab will be available for use by all teams on Fridays, subject to capacity limits on a first-come, first-served basis. Reservations will be given preference over walk-ins, so please book early. To make a reservation, email the Lab Staff with: a Friday time range, along with the names of all students on the reservation.

Each tutorial section contains up to 6 teams, where each team contains at most 6 students. At the end of each tutorial, tutors will check off team deliverables as listed below. Team checkoffs are not specifically graded, but are meant to provide milestones that will help your team complete the project in the allocated time.

Tutorial #	**Team Goals/Deliverables**	
T1 Wks 2–3	▷ Lab intro/safety form ▷ Receive parts kit	▷ Wire motors & battery holders ▷ Cut and fold base template
T2 Wks 5–6	▷ Wire template robot ▷ Brainstorming	▷ **Complete template robot** ▷ Begin prototyping
T3 Wks R–7	▷ Prototyping ▷ Revisions	▷ Work-in-progress prototype ▷ **Robot reaches wall**
T4 Wks 8–9	▷ Refinement ▷ Testing	▷ Nearly-finished prototype ▷ **Robot can hold/release ball**
T5 Wks 10–11	▷ Finished prototype ▷ Work on video & paper	▷ **Graded runs on course** ▷ Storyboard/script for video
T6 Wks 12–13	▷ Course wrap-up ▷ Dismantle/return parts	▷ **Present video**

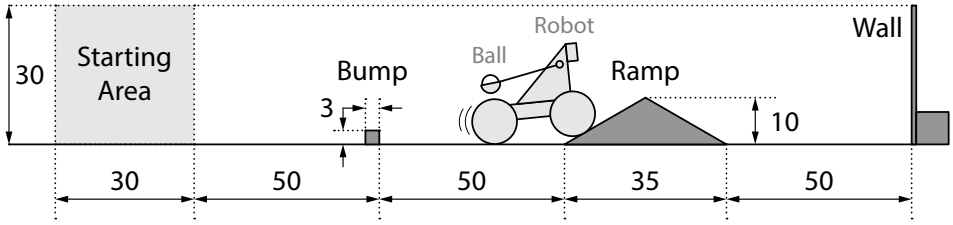
Teams are not expected to be able to fully complete the project by only working in the lab during the scheduled tutorial sessions. As such, teams are expected to **meet outside of lab** for two hours during off-weeks to work on the project.

Laboratory Safety

Tutorials will be held in the E4-02-06 Fabrication Laboratory. **Before attending the first tutorial section**, each student is required to watch the safety overview in the Week 1 lectures. In your first lab session (T1 in Wks 2–3) you will be asked to sign a safety form acknowledging that you have been briefed on lab safety. Please abide by the following rules whenever you are in the lab:

- No food or drink in the lab.
- No open-toed shoes or sandals. Closed-toed shoes are required.
- No shorts or skirts. Long pants are required.

Project



Each team is tasked with building a self-powered robot that:

- navigates an obstacle course consisting of a starting area, a bump, a ramp, and a wall, and
- delivers a ping pong ball over the wall.

The robot must be designed to meet the following specifications:

- The robot must fit within a $30 \times 30 \times 30$ cm cubic at start.
- The robot must be made using only the materials provided.
- The team may not interact with the robot after it leaves the starting area.
- The team may not attach anything to the ping pong ball.
- The robot has up to 30 seconds to complete the course.

In Tutorial 5, you will be allowed at most three graded runs on the course which must be observed by your Tutor. Your team's score on the Obstacle Checkoff will be the maximum score of your three graded runs. The score for a graded run is an integer between 0 and 10 corresponding to the sum of the following rubric items that are true during the run:

Base Pts	Rubric Item
$+1$	All of the robot passes the bump
$+1$	All of the robot passes the ramp
$+1$	Part of the robot reaches within 5 cm of the wall
$+1$	No part of the robot touches the wall
$+1$	Robot is in contact with the ball after passing the ramp
$+1$	Ball leaves contact with robot after passing the ramp
$+1$	Ball goes over the wall

Weight Pts	Rubric Item
$+1$	Robot is not the heaviest among robots in the same section scoring all 7 base points
$+1$	Robot is the lightest among robots in the same section scoring all 7 base points

Extra Pt	Rubric Item
$+1$	After scoring all 7 base points, all of the robot returns behind the bump

Report

Each team is required to submit a team report containing a body and appendix. The **body** of the report is a description of lessons learnt during the project design process, describing any difficulties and how they were overcome. The body should be no more than **5 pages, 12pt Times New Roman, single spaced**, excluding title page, contents, and appendix. The **appendix** should contain the following information (no page limit, but your Tutor may not be happy if its length is excessive).

1. A photograph of the final physical robot.
2. A CAD rendering of a model for the complete final robot.
3. An image of a TinkerCAD diagram corresponding to the circuitry of the final design.
4. The Arduino source code deployed on the final design.
5. A fully-dimensioned 2D CAD drawing for each structural component made from sheet material used in the final design, depicting how it was cut. For each part, include the material used (acrylic, cardboard, polypropylene, foam core, or paper).

Reports should be submitted to Canvas under the Assignments section by the **start of your final lab session, Tutorial 6**. Please submit your report as a PDF (e.g., not as a Word document) named as `'BXX_TeamY_report.PDF'`, where `XX` is your tutorial number and `Y` is your team number. The title page of your report should list the names of all members of your team, in addition to your section and team numbers.

While the purpose of the report body is to describe the journey and lessons learnt during the design process, the purpose of the report appendix is to provide documentation that would be necessary to reproduce your team's final design and results. The body and appendix are weighted equally in assessing the report. Rubrics for how these components will be graded are provided below. Report components will be moderated so that the average mark given by any tutor is no more than $8/10$.

	Report Body (10%)		Report Appendix (10%)	
Mark	Lessons Learnt (5)	Communication (5)	Content (5)	Quality (5)
5	Exceptional	Comprehensive	Contains all items	Exceptional
4	Substantive	Clear	An item incomplete	Substantive
3	Partial	Adequate	Missing 1 item	Adequate
2	Superficial	Poor	Missing 2 items	Low
1	Inadequate	Very Poor	Missing 3+ items	Very Low
0	None submitted		None submitted	

Video

Each team is required to submit a team video to clearly communicate their final project. Your video will be shown to the rest of your section during Tutorial 6. There will be a brief Q&A following each video so that the other students in your section can ask your team questions (your team will be required to answer at least one question). The video should contain:

1. the names of your team members, and your section and team numbers;
2. documentation of your team's brainstorming, selection, and prototyping process;
3. discussion of design choices made that differentiate your robot from other teams;
4. at least 1 difficulty that was overcome; and
5. video of the final robot on the obstacle course (the video may be shown faster than real time).

The video should be no longer than 5 minutes, and may be in any presentation format (e.g., Ted Talk, animation, etc.). Videos should be submitted to Canvas under the Assignments section by the **start of your final lab session, Tutorial 6**. Please submit your video named as `'BXX_TeamY_video'`, where `XX` is your tutorial number and `Y` is your team number. Video size is limited to **at most 500 MB**. Your video will be assessed by 2 equally weighted components: content and presentation, based on the rubrics provided below. It will be graded both by your peers (10%) during Tutorial 6, and by another section's tutor (5%), each on a 10 point scale according to the following rubric. Video marks will be moderated so that the average mark given by any individual is no more than $8/10$.

Mark	Content (5)	Presentation (5)
5	Exceeds expectations	Exceeds expectations
4	Comprehensive	Clear and Compelling
3	Adequate	Clear and Adequate
2	Vague	Lacks clarity
1	Insufficient	Poor
0	None submitted	

Internal Peer Review

Each student will be asked to review the other members of their team twice during the term. Please rate your teammates according to their attendance, contributions, and communications. The average of your reviews should be no more than $8/10$. If not, your reviews will be moderated so that they are. Rubrics to guide your reviews are given below. **If you do not submit a peer review, you will be ineligible to receive peer review marks**.

Mark	Internal Peer Review (5% Midterm, 10% Final)
9 – 10	Participates beyond expectations. Attends regularly.
7 – 8	Participates consistently. Attends regularly.
5 – 6	Participates much of the time. Attends most meetings.
3 – 4	Participates sometimes. Attends most meetings.
1 – 2	Minimal participation. Missing from most meetings.
0	Does not participate. Missing from most meetings.