ELEC 3300
Introduction to Embedded Systems

Course Introduction

Prof. Vinod Prasad

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Email: eevinod@ust.hk

Course Arrangement for Fall 2021

All the Lectures, Tutorials, LABs and Project will be running ONLY Face to Face Mode.

Students who are not able to attend face to face are suggested to take the course in Spring Term.

ELEC 3300 Introduction to Embedded Systems

- Teaching Team:
  - Course Instructor:
    - Prof. Vinod Prasad (email: eevinod@ust.hk , Room 2437)
  - Teaching Associate:
    - Fox C H WU (email: eefox@ust.hk , Room 2395)
  - Technicians:
    - Darwin T W WONG (email: eetwwong@ust.hk, Room 3130)
    - Sam C W LAI (email: eecwlai@ust.hk, Room 3130)
  - Teaching Assistants:
    - To be arranged

ELEC 3300 Introduction to Embedded Systems

- *Course Notes and Lab Notes: CANVAS system*

- *Course prerequisites*
  - COMP2611/ELEC 2300/ELEC2350 Computer Organizations
    - Basic assembly language programming
    - Basic structure of a processor

- *Background Knowledge*
  - ELEC 1100 Introduction to Electro-Robot Design
    - Digital logic circuits designs
    - Simple circuit timing and timing diagrams
    - Electronic devices measurement

Teaching and Learning Activities

- Teaching activities
  - Lecture: 2 x 1.5-hour sessions (Week 1 to Week 7)
  - Tutorial: 1.5-hour sessions (Week 1 to Week 7)
  - Laboratory experiments: 2-hour sessions (Week 3 to Week 9)
  - Mini-talks: (Week 10 to Week 11)
  - Project: Talent-made schedule (Week 7 to Week 13 inclusive)

- Other activities:
  - Preliminary proposal discussion
  - 1 Final proposal presentation
  - 1 Interim project demonstration
  - 1 final project demonstration

- As there is no examination in this course, your participation and contribution is very important.

Teaching, Learning Activities and their grading scheme

- Continuous assessment:
  - In-class activities 8%
    - The in-class activities in the first two weeks are the pilot run. The score will be counted toward starting from week 3.
    - There are two criteria in measuring the score:
      - First 6% is counted in the percentage of the questions you attempted.
      - The rest 2% will be given if more than 70% of the answers are correct.
  - 2 Homework assignments 10%
  - 6 Laboratory experiments 18%
  - 1 Preliminary proposal discussion (peer) 4%
  - 1 Proposal presentation 6%
  - 1 Interim project demonstration 9%
- Final assessment:
  - 1 Final project demonstration and presentation 40%
  - 1 Final report 5%

Late submission of assignment

- To be fair for those students who submit assignment on time, a penalty of late submission is listed as follow:
  - Late submission within 12 hours, Penalty of 25%
  - Late submission between 12 to 24 hours, Penalty of 50%
  - We will not accept any late assignment for more than 24 hours.

Passing Requirement

- Passing requirement of the course is
  1. Attend all the 6 laboratory experiments with demonstration
  2. Composite score > 45%

- If you miss any meetings, a makeup meeting can be arranged if you could provide a supporting document.

- Only maximum of one makeup meetings can be arranged.

Lecture Topics

1. Introduction to Embedded Systems
2. Basic Computer Structure
3. Microcontroller Structure
4. Interrupt Organization
5. Timer and Counter
6. Interfacing LCD
7. Motor Interfacing

Tutorial Topics

1. Introduction to use of Equipment
2. Number System and STM32 Structure
3. I/O and Interrupt function of STM32
4. Controlling Graphic LCD using FSMC function of STM32
5. STM32 Timer and PWM Function
6. ADC of STM32
7. I2C function of STM32

LAB Topics

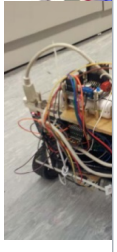
1. Use of Equipment
2. I/O Interface, Interrupt function of STM32
3. Graphic LCD Interfacing
4. Timer and PWM Function
5. ADC Applications
6. I2C Interface Programming

ELEC 3300 Introduction to Embedded Systems

Team size : 2 students

Evaluated by Project Grading Rubric

Student initiated projects



ELEC 3300 Project Grading Rubric

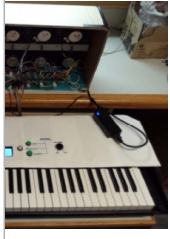
Project Demonstration: Max 32 marks

Project Presentation: Max 8 marks

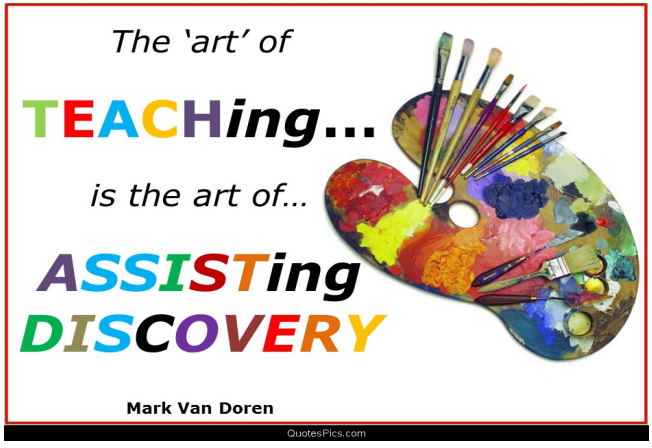
Acknowledgment - This rubric is adopted and modified from the INQUIRY AND ANALYSIS VALUE RUBRIC by Association of American Colleges and Universities. Number in bracket shows the corresponding marks for that level of performance.

	Capstone	Milestones		Benchmark
	4	3	2	1
Project Complexity (P03)	The whole project consists of a complex hardware and software design. Careful hardware design and software design algorithm is being shown. (12)	Hardware consists of various kind of interface before going to the processor, with software controlling the other interfaces. (9)	Project hardware is a mix of analogue and digital signals, software part used all the features of the processor. (6)	The processor directly controls all the aspects of the hardware, simple controls are used in the software. (3)
Project Understanding (P05)	Clear understanding of the project. System is designed with justification and appropriate use of analog, digital signals and methodology. (10)	System is designed with appropriate use of analog, digital signals, and correct methodology. (6)	System is simply designed according to the LAB understanding. Cannot justify uses of analog or digital signals or methodology. (4)	Little understanding of the project. System is designed without justification of LAB knowledge or methodology. (2)
Project Originality	Application of labs together with extra circuits or software extended to creative design. (6)	Extended integration of lab materials with extra circuits or software. (4)	Project is an application of all the labs done before. (2)	Project is an application of two to three of the lab experiments. (1)
Completeness (P10)	The project can run smoothly without major error. (4)	The project can run with specified inputs. It encounters error with input that is not specified. (3)	The project can run, however, it encounters errors on specified input. (2)	The project cannot run, however, can show partial functionality with forced input with either hardware or software. (1)
Oral Presentation with PowerPoint	Presentation referenced to information or analysis that significantly supports the project work. (8)	Project presentation is clear and consistent with the supporting material. (6)	Fair description of project, still understandable, but is not often repeated and is not memorable. (4)	Project function be deduced, but is not explicitly stated in the presentation. (2)

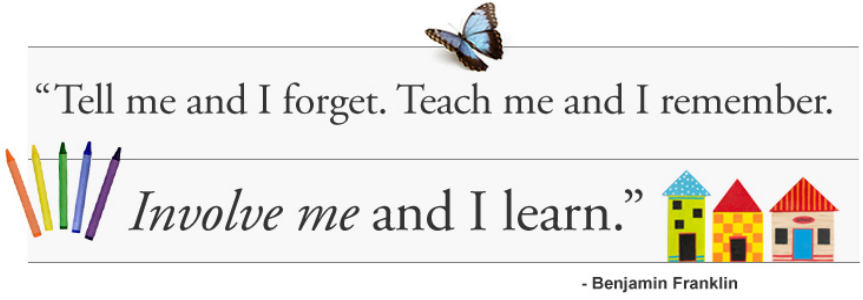
Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.



In the course design, we involve



- Student's centered learning
- Experiential learning



Homework Assignments,
Laboratory experiments,
Student's project

I hear and I forget, I see and I remember, I do and ***I understand.***
- Confucius (551 BC to 479 BC)

What do we teach?

We will NOT give you a fish; instead, we will teach you how to fish.

From project idea to prototype design

Developing since 2009

Description
Abstract idea of project (Define the functionality of the system)
…
…
…
…
Hardware devices (Microcontroller, Peripherals, sensors)

Self-driving car

http://goo.gl/Z0JLsy

Abstract idea:
- How does the car drive? Stop the car? Right steering? Move forward?
- How to guide the car from starting location to the destination?
- How to get the information about the surrounding?
- Can we change the driving path in the real time?
- What is the maximum driving speed?
- Does the car need to communicate with other vehicles?

Hardware devices:
- Which are the suitable / potential hardware devices in addressing each abstract idea?

What do we teach?

Self-driving car

http://goo.gl/Z0JLsy

Further information:
https://en.wikipedia.org/wiki/Waymo

From project idea to prototype design

Developing since 2009

Description
Abstract idea of project (Define the functionality of the system)
…
…
…
…
Hardware devices (Microcontroller, Peripherals, sensors)

Other potential devices for:
-global positioning
-Monitoring the tire pressure

Sensors

Automobile

Measurements

-**RPM** (Revolutions Per Minute): How many times the engine's crankshaft makes one full rotation every minute (Tachometer).

- **Speedometer:** Vehicle speed

-**Odometer:** Distance travelled

-**Fuel Level Gauge:** Fuel Tank Level (float and potentiometer / capacitance)

-**Temperature Sensor:** Inside and outside air temperature (Resistance Temperature Detector / Thermistor)

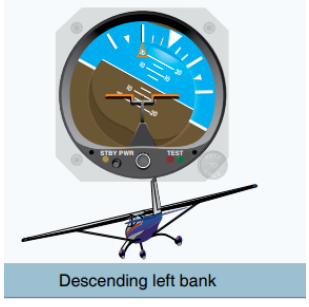
Sensors

Aircraft Instrumentation

Measurements

-**Altimeter:** Altitude above sea level

- **Attitude Indicator:** Aircraft's orientation relative to the Earth's horizon



Heading indicator

- **Heading Indicator:** Aircraft's direction

-**Vertical Speed Indicator:** Rate of climb or descent of an aircraft

-Horizontal Speed, Fuel level gauge, Pressure, Temperature, Engine Vibration, Cabin Oxygen, Smoke, etc.

Sensors

Mobile Phone

Modern Mobile Phones have built-in sensors that measure motion, orientation, and various environmental conditions.

Accelerometer for motion ... ne acceleration force applied to a device on all t... entation, shake)

Temperature sensor: Air ...

Light sensor: Ambient lig... screen brightness)

Pressure sensor: Air press...

Proximity sensor: Proxim... to the screen

Humidity sensor: Relativ...

Android 4.0 Phone - LG Optimus L7

What is the scope of this course?

Overview of Computer systems

Applications

Operating Systems

Internal

I/O devices

External

Overview of Computer systems

Modern Computer Systems

Software

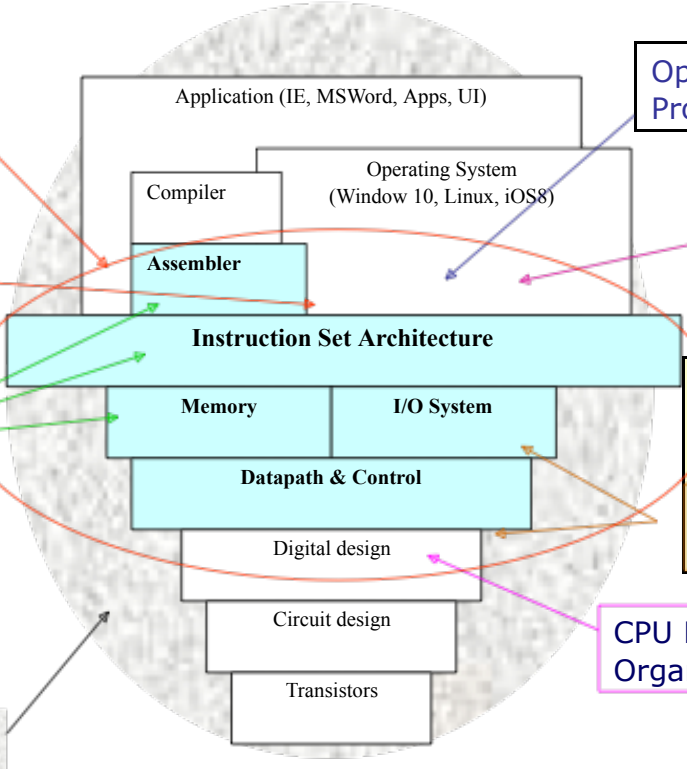
Memory Management

Kernel

Computer Architecture, CPU and Memory

Hardware

•Background
Data Representation and Floating Point Standards



Operating Systems and Process Management

I/O and File Systems

Our focus:

Interfacing techniques for system integration

Input, Output and Peripheral Devices

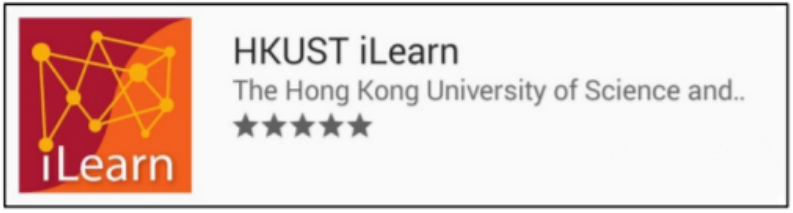
CPU Design and Organization

Outcomes Expected from YOU

- On successful completion of this course, you will be able to
  - CO1: Recognize the marketing and engineering views of embedded system applications.
  - CO2: Understand and analyze the building blocks of embedded system, and the interfacing techniques of simple external devices.
  - CO3: Understand and compare different up-to-date computer interfacing technologies.
  - CO4: Use CAD tools to program and emulate the performance of the micro-controller.

First in-class activity

For Android devices, search **HKUST iLearn** at Play Store.



For iOS devices, search **HKUST iLearn** at App Store.

Course Outline

- Which knowledge do I learn in class and how do they link up?

Course Outline:

1. Introduction to Embedded Systems
2. Basic Computer Structure
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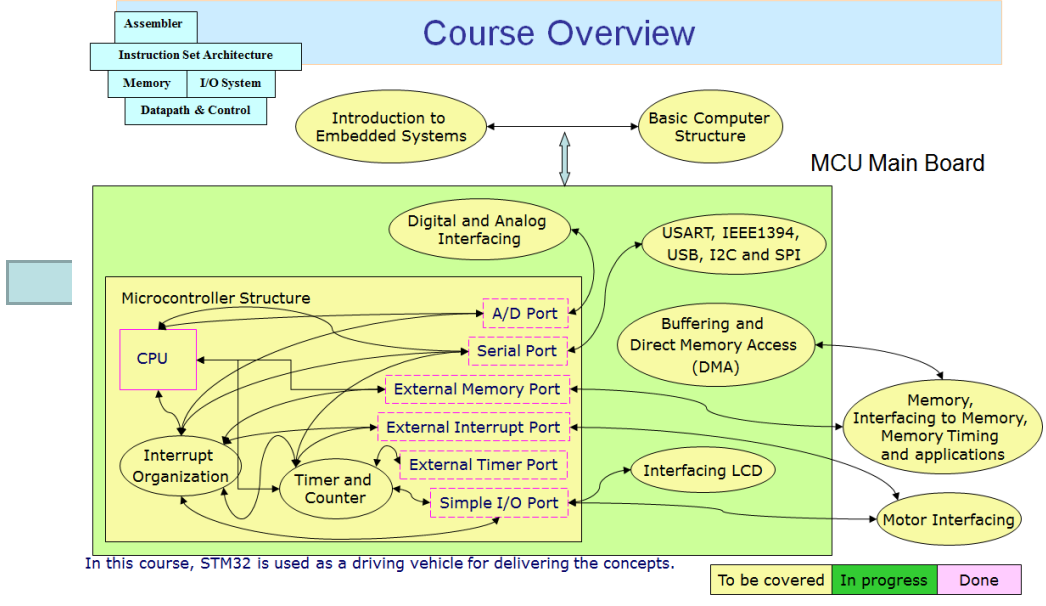
5. Timer and Counter
6. ……
7. ……
8. Interfacing LCD
9. Motor Interfacing
10. ……



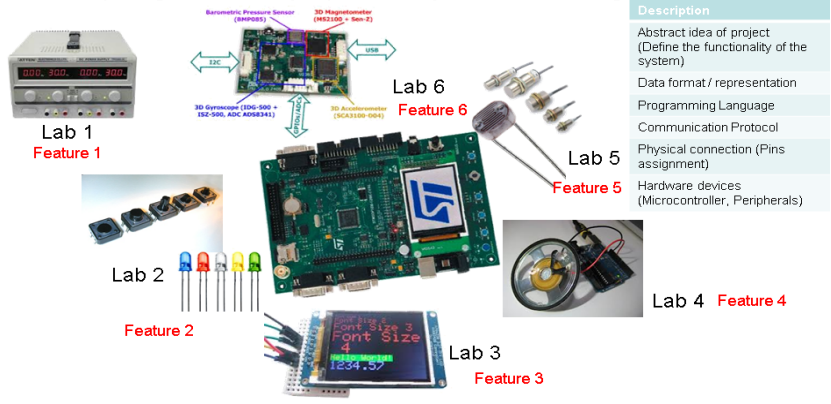
Laboratory

- Objective (CO2 and CO4)
  - Enrich your knowledge in the circuit interfacing and basic programming skills with CAD tools

- A brief discussion on the laboratory experiment will be conducted in tutorial sessions.

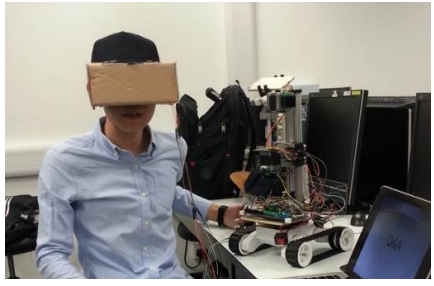
Design architecture of an embedded system

- After completing the laboratory experiments, you are able to integrate

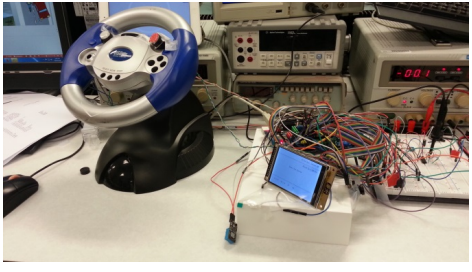


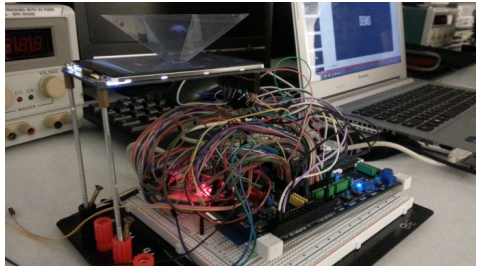
Course Project

- Objective (CO5):
  - Put in practice what you have learned in both hardware and software skills in your talent-made project
  - Work effectively in a team and lead a team



- Team size:
  - 2 students from same / different laboratory sessions
    - Please submit your team to the Teaching Associate within three weeks. Otherwise, you will be randomly assigned. (Please check the CANVAS)





Course Project

- At the end of the course, you are able to submit:

– Final Project Demonstration + Power-point Presentation
  - Each team is required to conduct a fifteen-minute demonstration and presentation.

– A final project report in HTML format

– Peer-evaluation from your team member (this reflects your overall performance in the project)

You may ask about the grading ……

- How do you grade my project?

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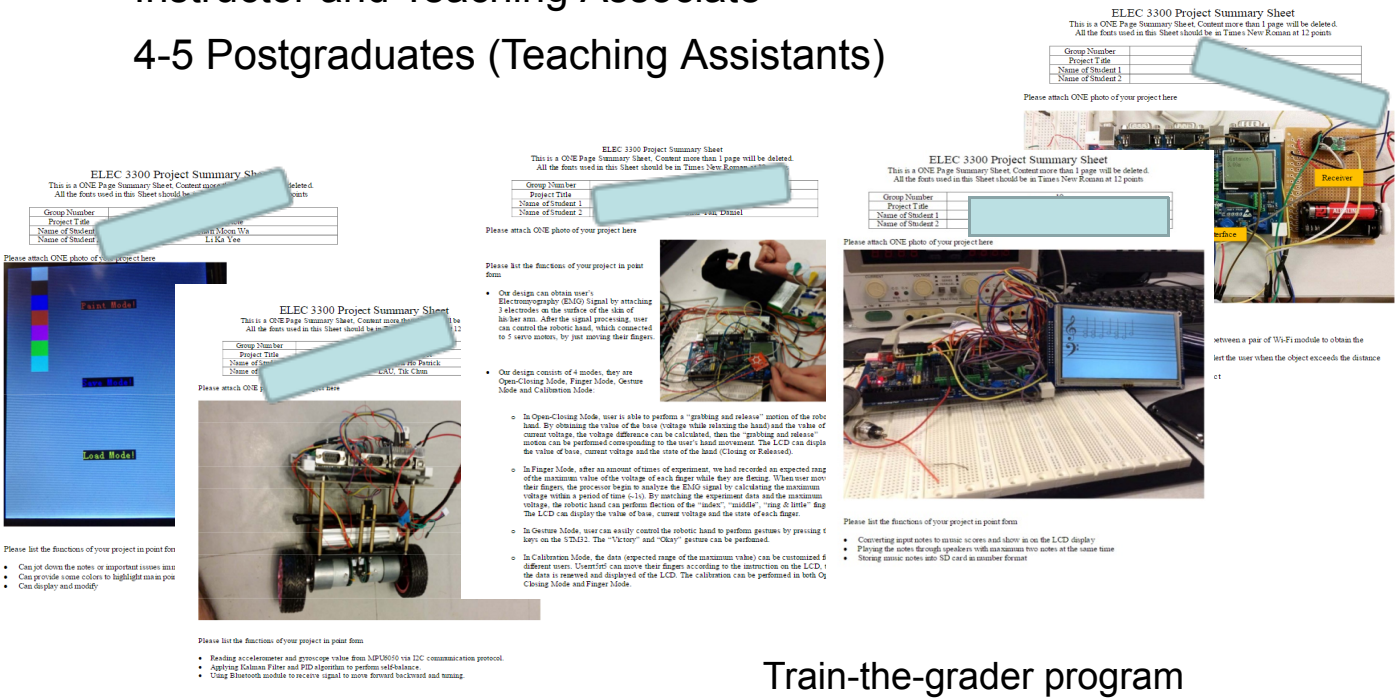
You may ask about the grading ……

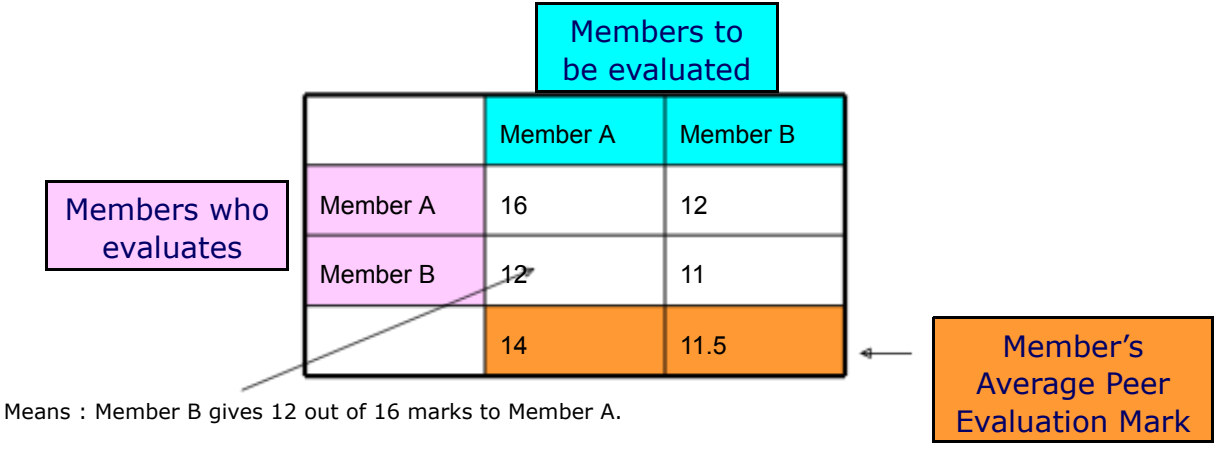
- Who grade the project? Is the grading fair?
  - Instructor and Teaching Associate
  - 4-5 Postgraduates (Teaching Assistants)



Train-the-grader program

Project Assessment – Peer evaluation

- You are required to do peer evaluations to your group member during the project period.
- Below shows an example, each evaluation mark will be from 0 – 16.



Group's Average Peer Evaluation Mark = (14 + 11.5) / 2 = 12.75

Members Difference percentage = (14 – 11.5)/12.75 = 19.6%

Project Assessment – Peer evaluation

- Based on the difference in percentage, the project mark that got by the member will be multiplied by a factor as shown in the table

Difference	Factor for Member A (More)	Factor for Member B (Less)
0 – 10%	1	1
10 – 20%	1 + X	1 – X
20 – 30%	1 + Y	1 – Y
> 30%	1.2	1 – 2Z

- Note: $0 < X < Y < Z < 0.5$

Project Assessment

- We will also monitor the progress and the reflection from peer evaluations in order to achieve a fair environment.
- A special meeting will be arranged if some abnormal case is observed.
- You should seek for help as early as possible if you have any difficulties. There is nothing we can help in the last minutes.
- A normalization of progress marks among different assessor will be done.

Project Nomination

- In order to engage your engineering design abilities,
  - we will nominate some good projects in participating some local, national and international competitions.

Outcomes and Means

- Outcomes:
  - To be a well-trained UG student and get success, you need …….
    - Team work, Discipline, Both theoretical and technical knowledge, Creativity, Good Presentation skill, Good in Time Management
- How can we help you in this course?

	Lecture / Tutorial	Lab experiment	Project
Team Work		✓	✓
Discipline		✓	✓
Theoretical knowledge	✓	✓	✓
Technical knowledge	✓	✓	✓
Creativity			✓
Presentation skill			✓
Time Management	✓	✓	✓

- Important Note: Curve fitting is NOT applied in the letter grade assignment. Much effort you put, higher grade you get.