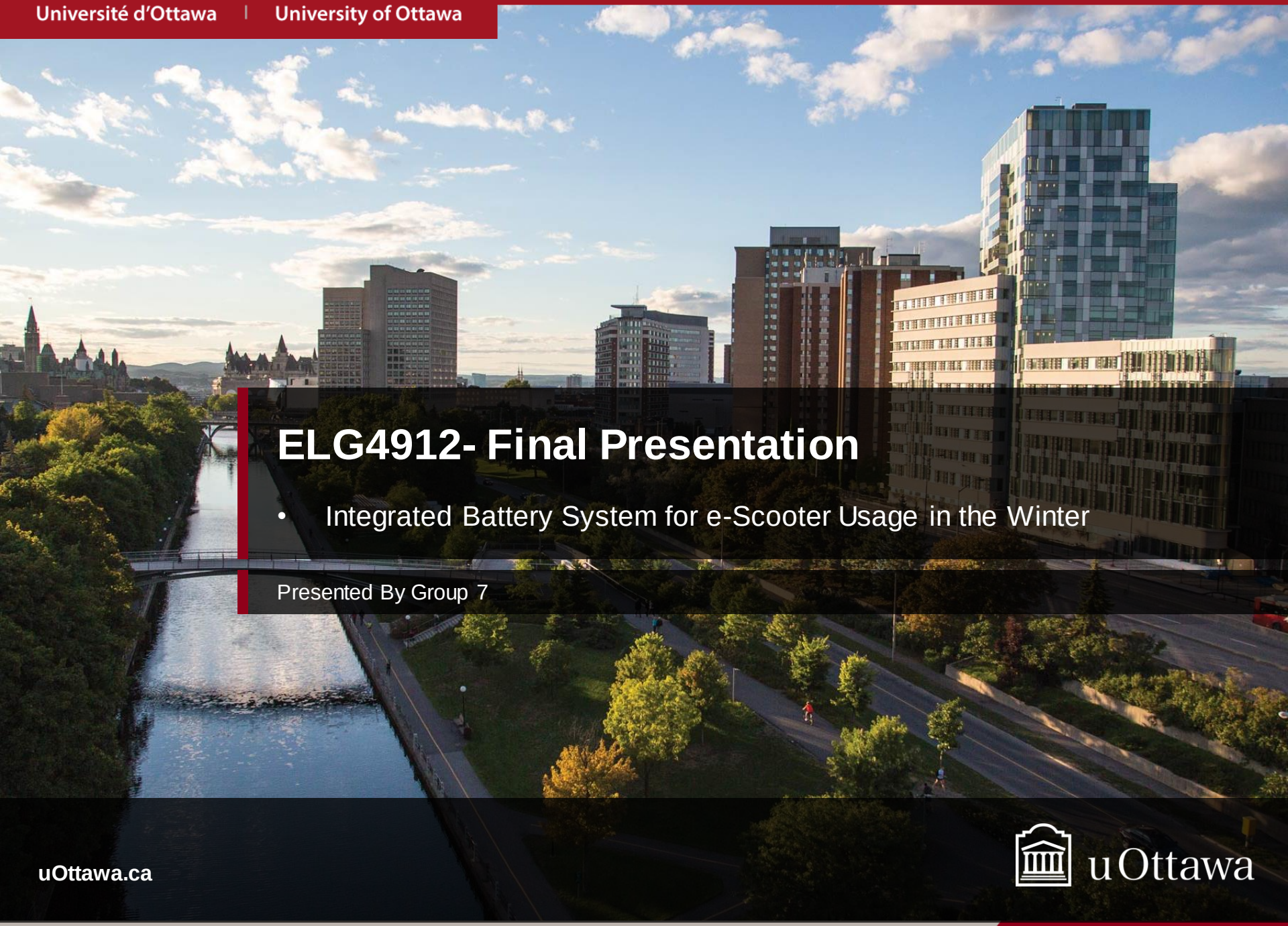


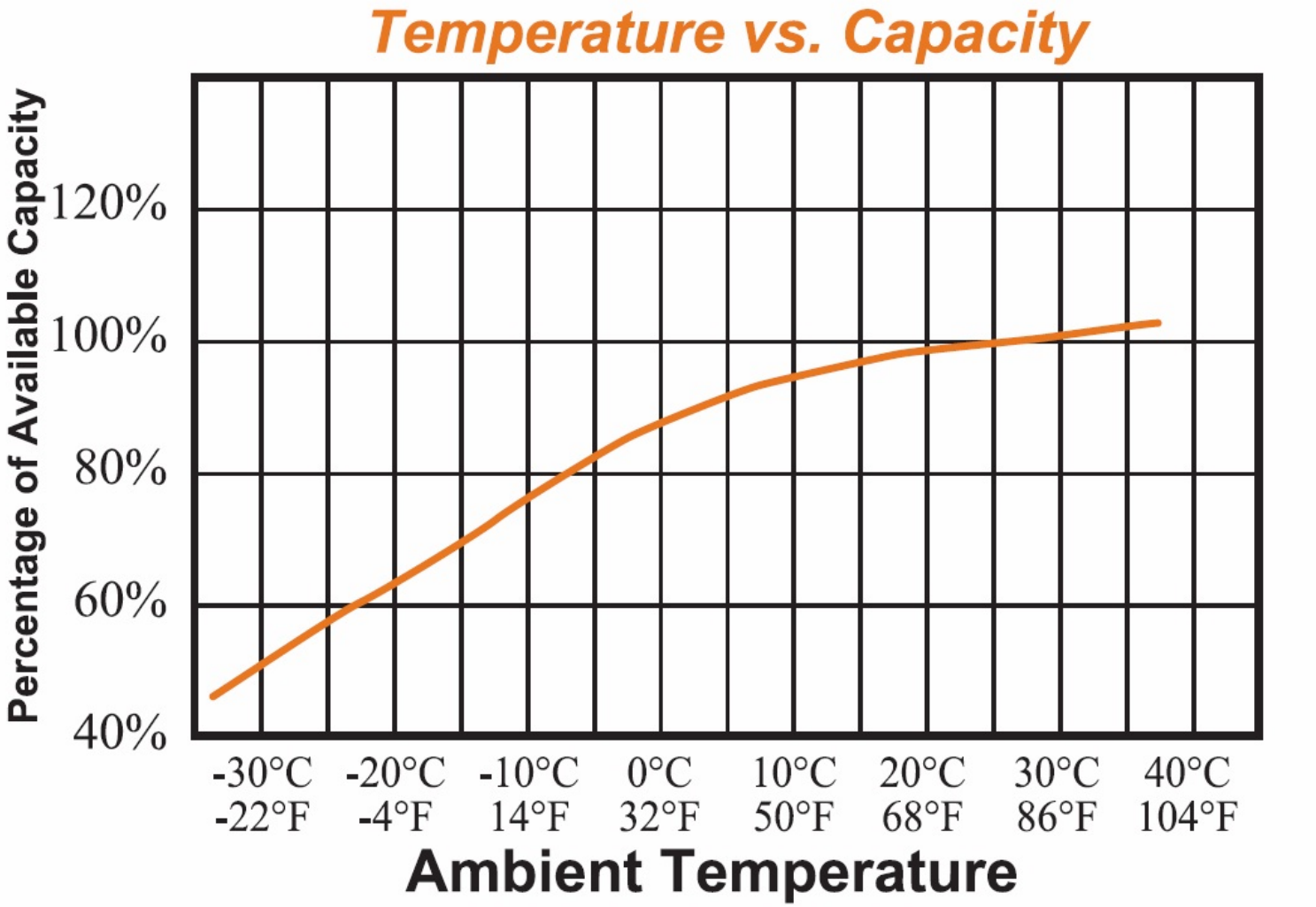
ELG4912- Final Presentation

- Integrated Battery System for e-Scooter Usage in the Winter

Presented By Group 7

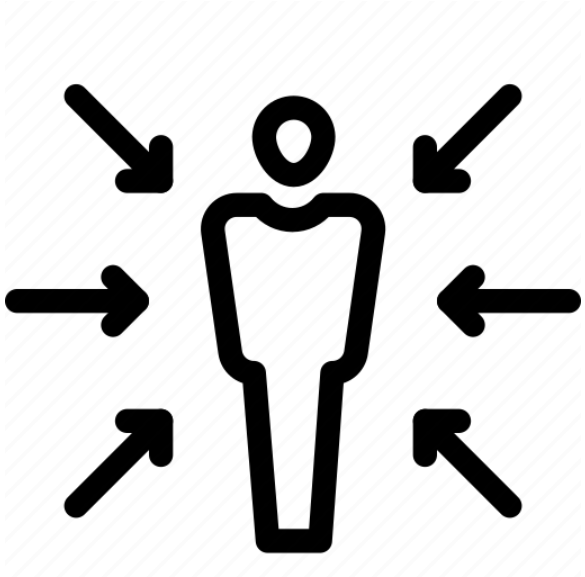
Goal: Increase e-scooter usage during the winter

-7°


Temperature vs. Capacity
Percentage of Available Capacity
120%
100%
80%
60%
40%
-30°C
-22°F
-20°C
-4°F
-10°C
14°F
0°C
32°F
10°C
50°F
20°C
68°F
30°C
86°F
40°C
104°F
Ambient Temperature

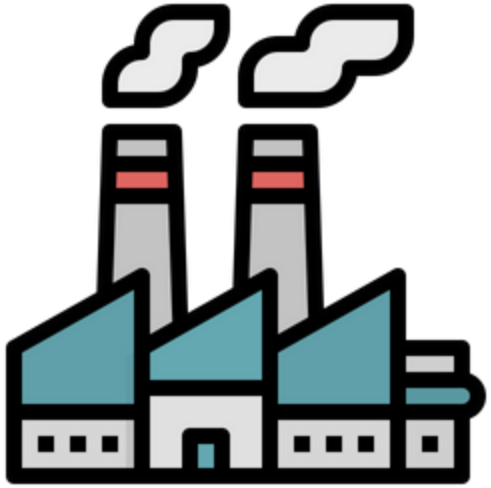
Customer

Individual User



E-scooter Renting Business

Vendor/Industry

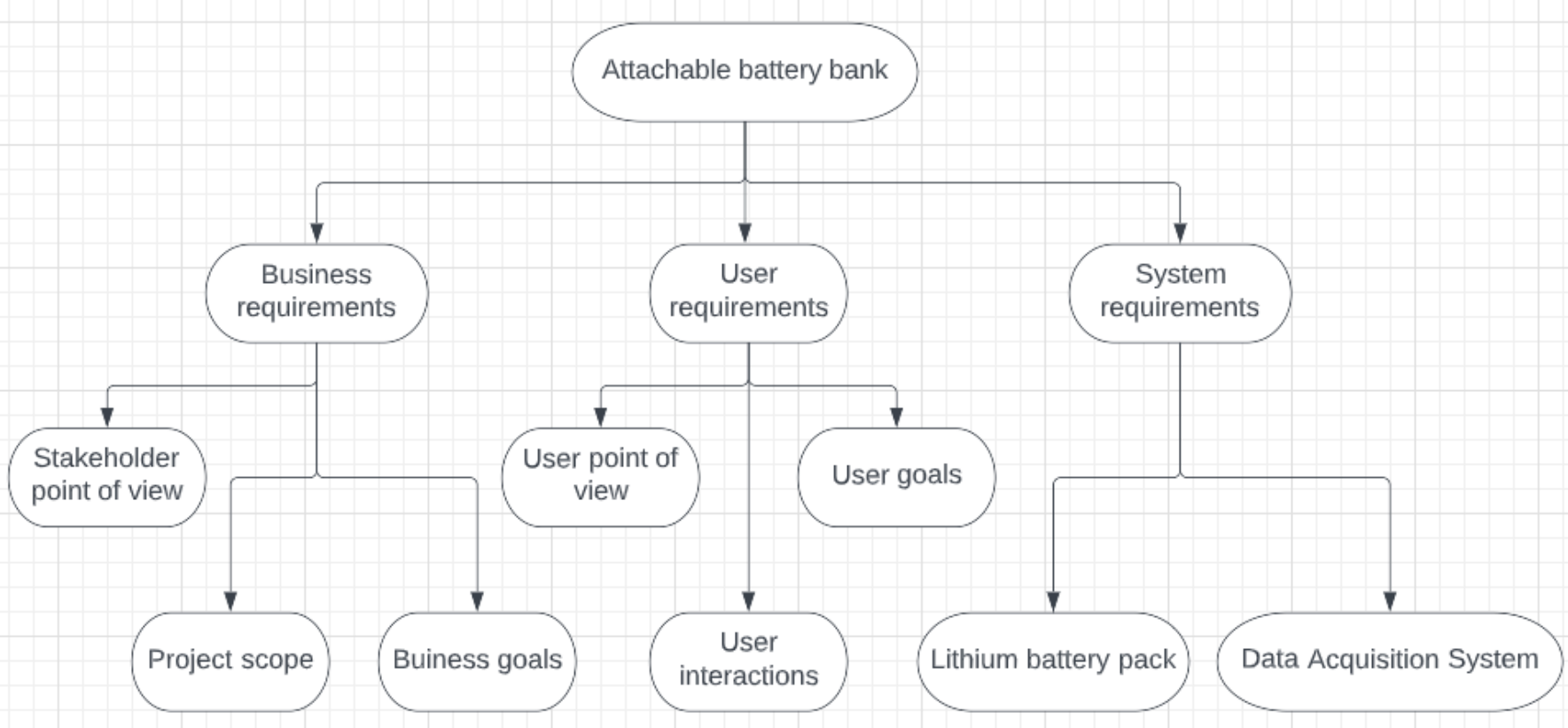


Business Case

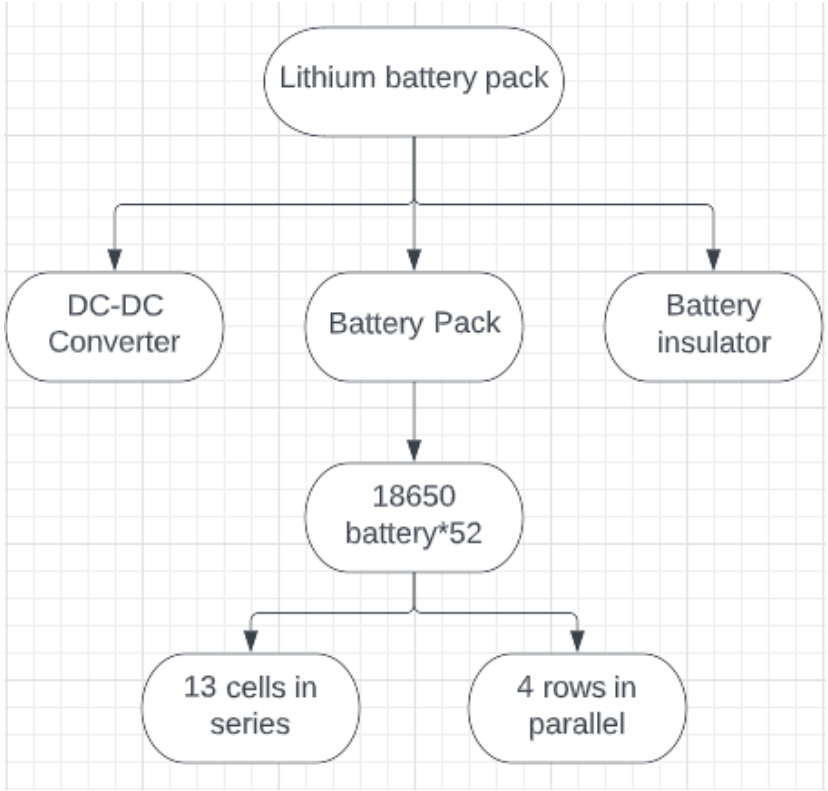
Retail Price
$499.99

Renting Price
$12.99 Monthly
$49.99 Seasonal

Functional Requirements

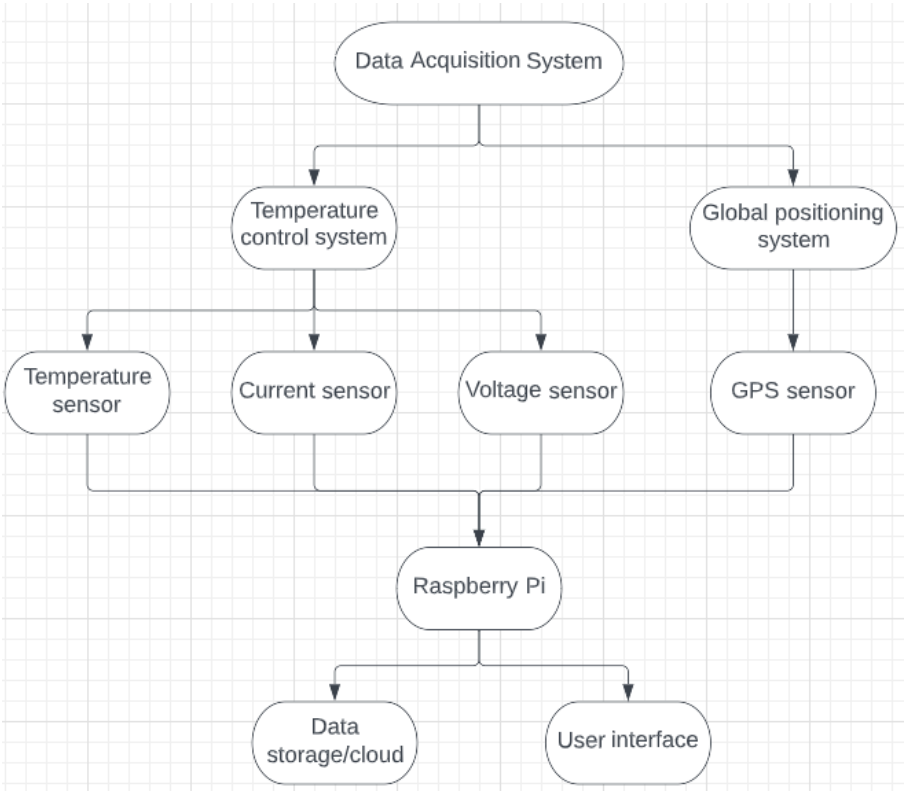


Functional Requirements



- 18650 cell
- Operated from 3.0 - 4.2 volts
- Excellent energy density
- Excellent longevity
- Prevent dust
- Last longer

Functional Requirements



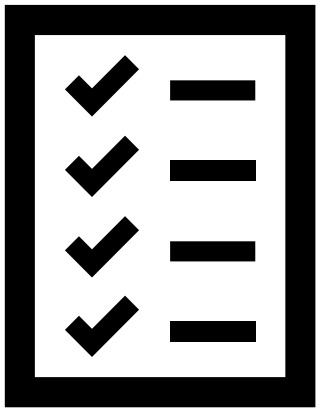
- Automatic control
- Heating up battery in cold winter
- Prevent the battery from overheating
- Track e-scooter
- Route record
- Data storage/Data display

Non-Functional Requirements

- Performance and scalability: High response speed
- Portability and compatibility: Easy to install and carry
- Reliability/Maintainability: Lifespan up to 3 years
- Localization: Adapting to the Ottawa Environment
- Usability: Simple installation, no additional operations required

Assumptions

- Scooter needs to be functional on its own
- Our battery needs to be able to attach to the scooters charging port.
- Scooter must have common general charger
- Availability of equipment and materials



Risks

- Project Risks
  - Over/Under Voltage
  - Dead Shorts
  - Damaging Battery Physically
  - Charing in High/Low Temperatures

- Personal Risks
  - Fire Hazard
  - Shock Risks / Burns
  - Chemical Hazards (Inhalation/Irritation)

Hazard Assessment

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost Certain	High	High	Extreme	Extreme	Extreme
	Likely	Medium	High	High	Extreme	Extreme
	Possible	Low	Medium	High	Extreme	Extreme
	Unlikely	Low	Low	Medium	High	Extreme
	Rare	Low	Low	Medium	Medium	High

- Likelihood : Possible
- Consequence : Moderate

Risk Management

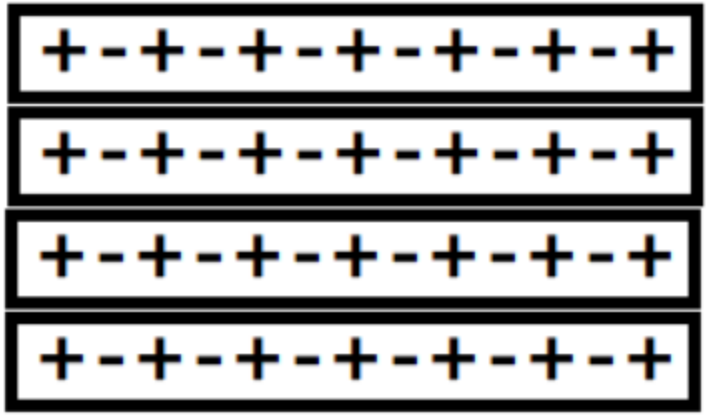
- Close Contact with Pierre Laflamme to mitigate risks
- Process Plan
- Emergency Plan
- Solutions for Battery Risks
  - Sensors
  - Enclosure / Insulation

Electrical Lab Safety

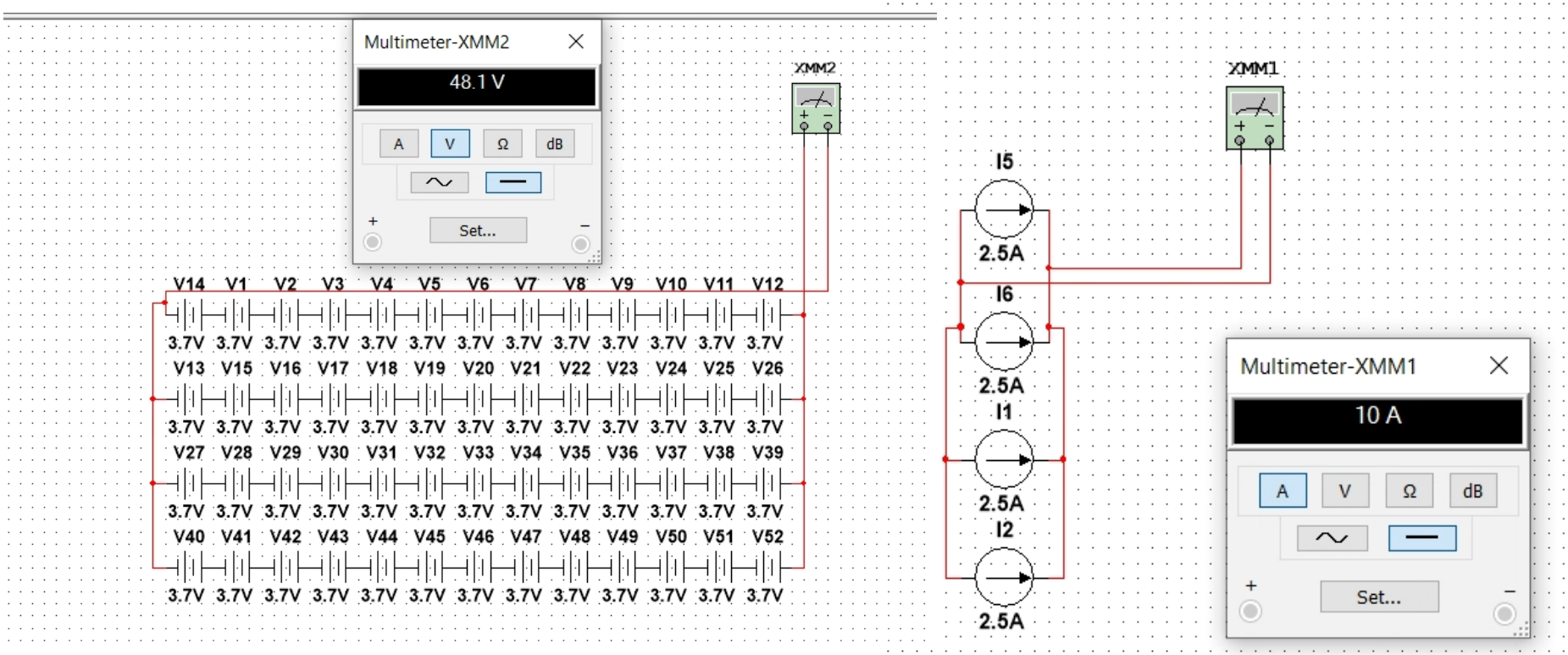
- Personal Protection Equipment
- Handling of Hazardous Materials
- Laboratory Preparation
- Awareness & Communication
  - We are never to work on this alone
  - Supervised by TA or other

Detailed Hardware Design

18650 Battery
48.1V
10A



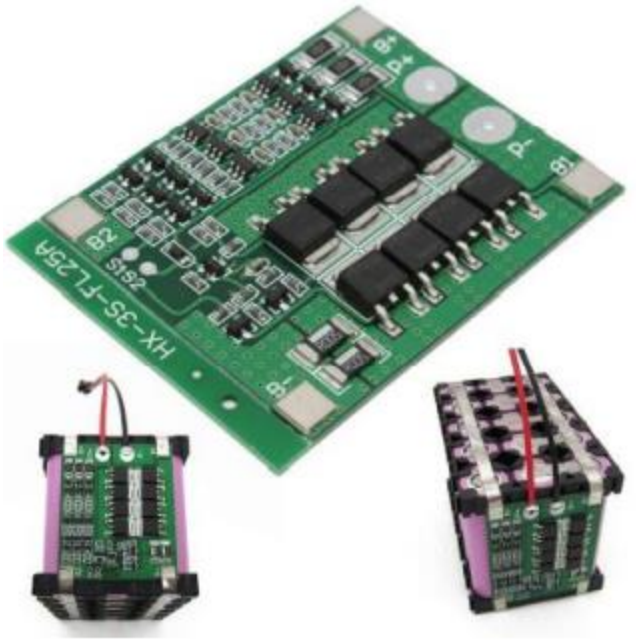
Hardware Simulation



Voltage	48.1V
Current	10A
Motor Consumption	250W
Power Supply	481W
Durability When Fully Charged	1.924Hrs

Additional Hardware Material (for safety measures)

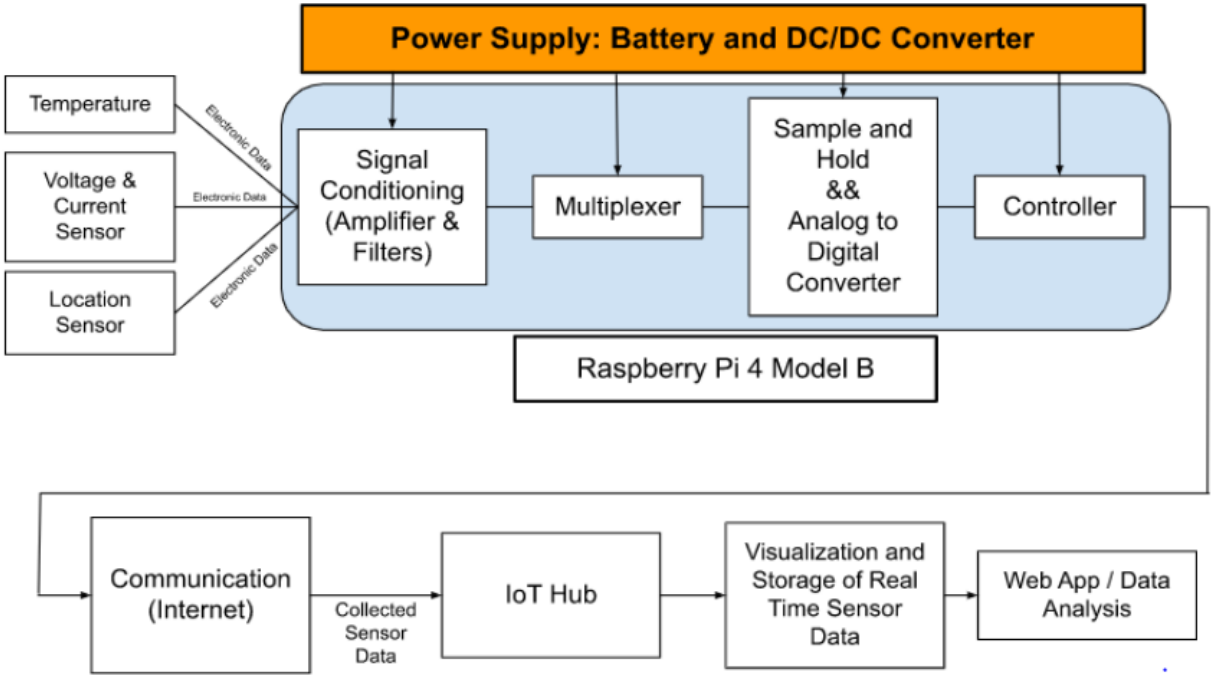
Battery Management System



Insulation Layer/Heat wrap

Software

- Overall block diagram
- Sensor -> Signal Processing -> Cloud -> Web

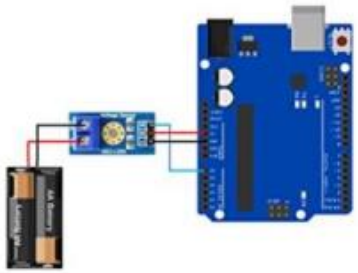


Sensors

Parameters	Specifications
Supply Voltage	3.3 V or 5.0 V
Temperature Range	$-55\,^{\circ}C$ to $+125\,^{\circ}C$
Accuracy	$\pm 0.5\,^{\circ}C$
Ground Pin	Connect to the ground of the circuit
Vcc	Powers the Sensor (5.0 V)
Data	This pin gives output the temperature value which can be read using 1-wire method

Table 5.1 - DS18b20 temperature sensor specs

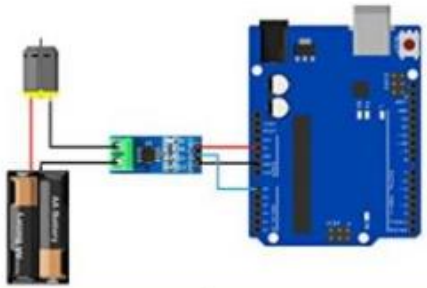
Temperature Sensor



Parameters	Specifications
Voltage detection range	0.02445 - 25V DC
Voltage Analog Resolution	0.00489V
Product Dimensions	16 x 10 x 2 cm; 20 Grams

Table 5.2 - WayinTop DC0-25V specs

Voltage Sensor



Parameters	Specifications
Chip	ACS712ELC-30A
Range of current detection	-30A to 30A DC
Analog Output	66mV/A
Product Dimensions	16 x 10 x 2 cm; 20 Grams

Table 5.3 - WayinTop ACS712 sensor specs

Current Sensor

Parameters	Specifications
Supply Voltage	3V - 5.5 V (typically 5V)
Current Output	50 mA
Operating Temperature	-40 to + 85 °C
Max Altitude	50,000 m
Max Velocity	515 m/s

Table 5.4 - Geekstory BN-220 sensor properties

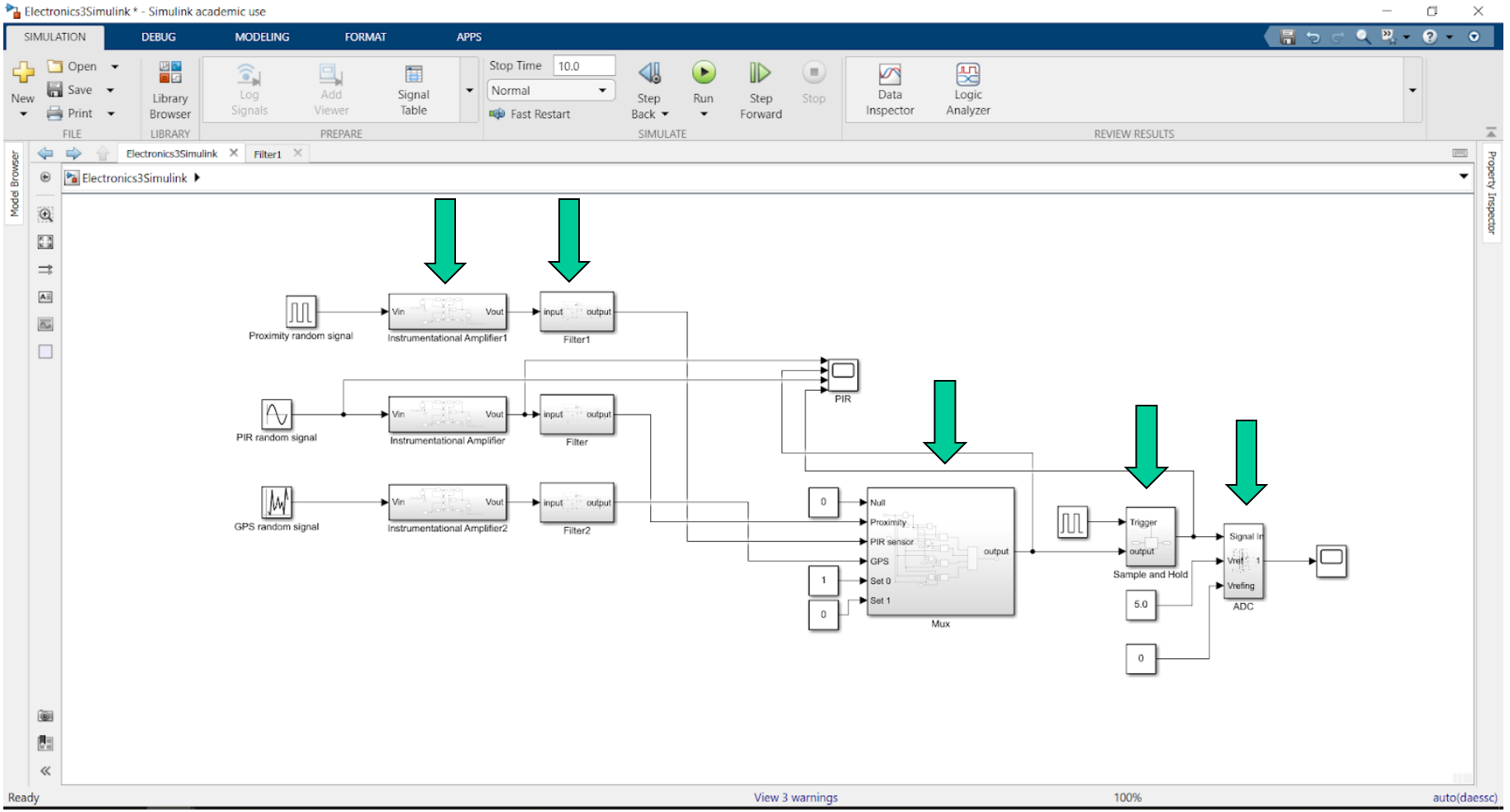
GPS Sensor

Simulation

- 2 different simulation:
  - Simulation 1: Simulation of Sensors, Raspberry Pi and its signal conditioning components.
    - Amplifier -> Filter -> Multiplexer -> Sample and Hold -> Analog to Digital Converter
  - Simulation 2: Connection of Raspberry Pi to Cloud, and data visualization for customers.
    - Raspberry Pi IoT Simulator (language used Python3) -> IoT Hub Microsoft Azure -> VS Code Console -> Power BI Data Visualization

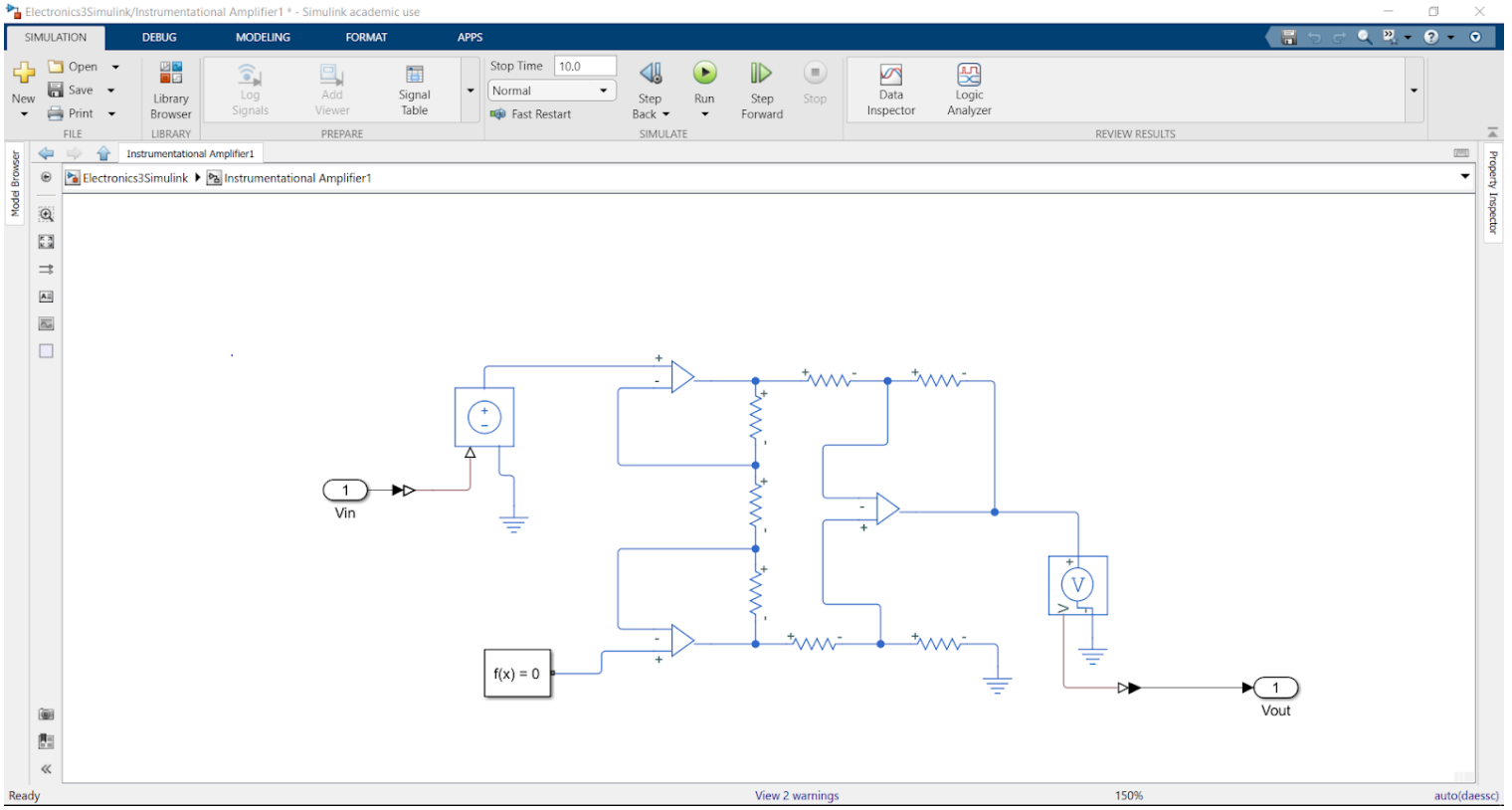
Simulation 1

- Overall Circuit



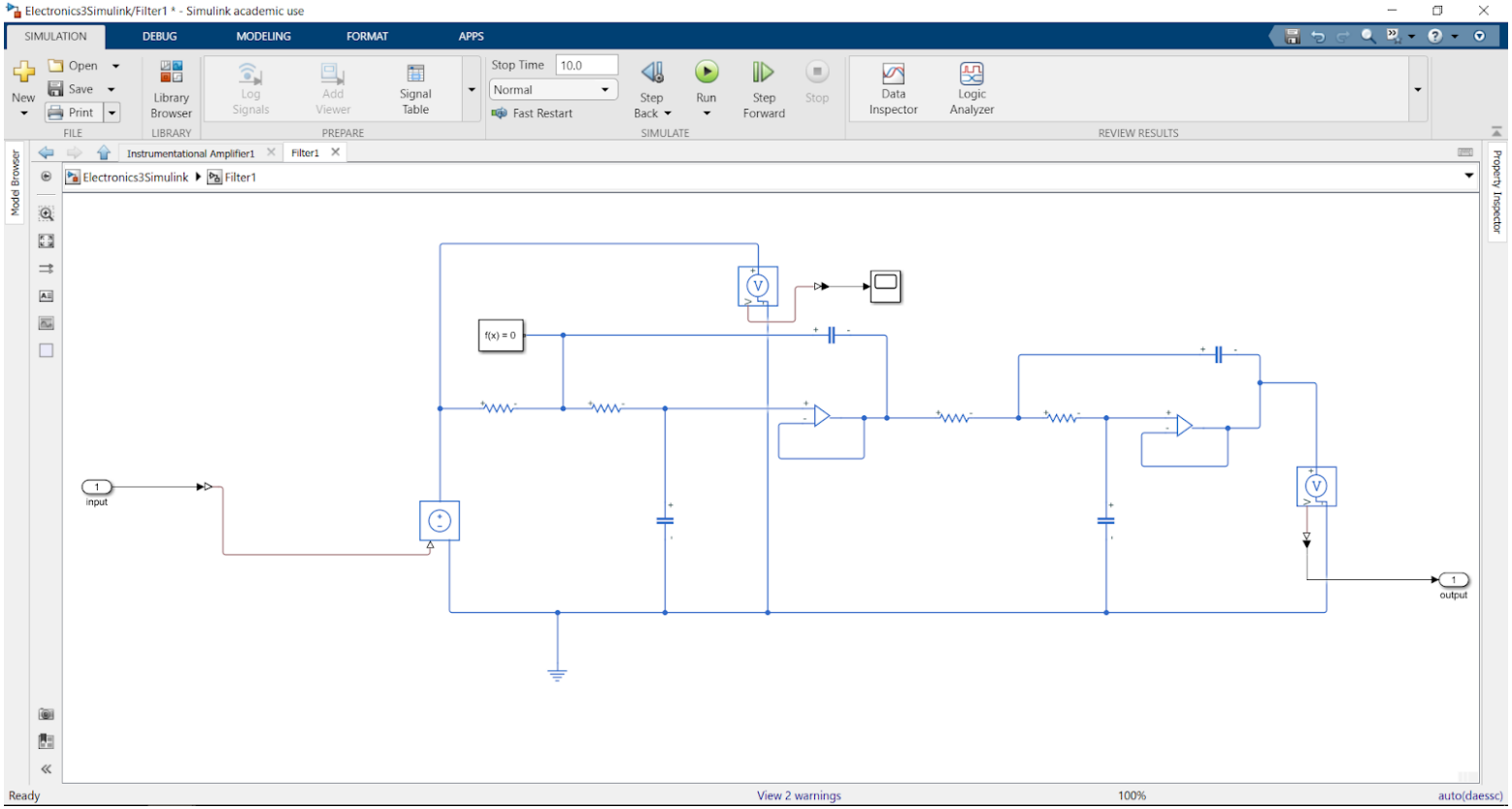
Instrumentational Amplifier

- Two non-inverting amplifier (A1,A2) followed by a Voltage Follower (i.e. Buffer)
- Very High Input Resistance
- Since f(x) = 0 this circuit only amplifies the Input signal (i.e. Vin)



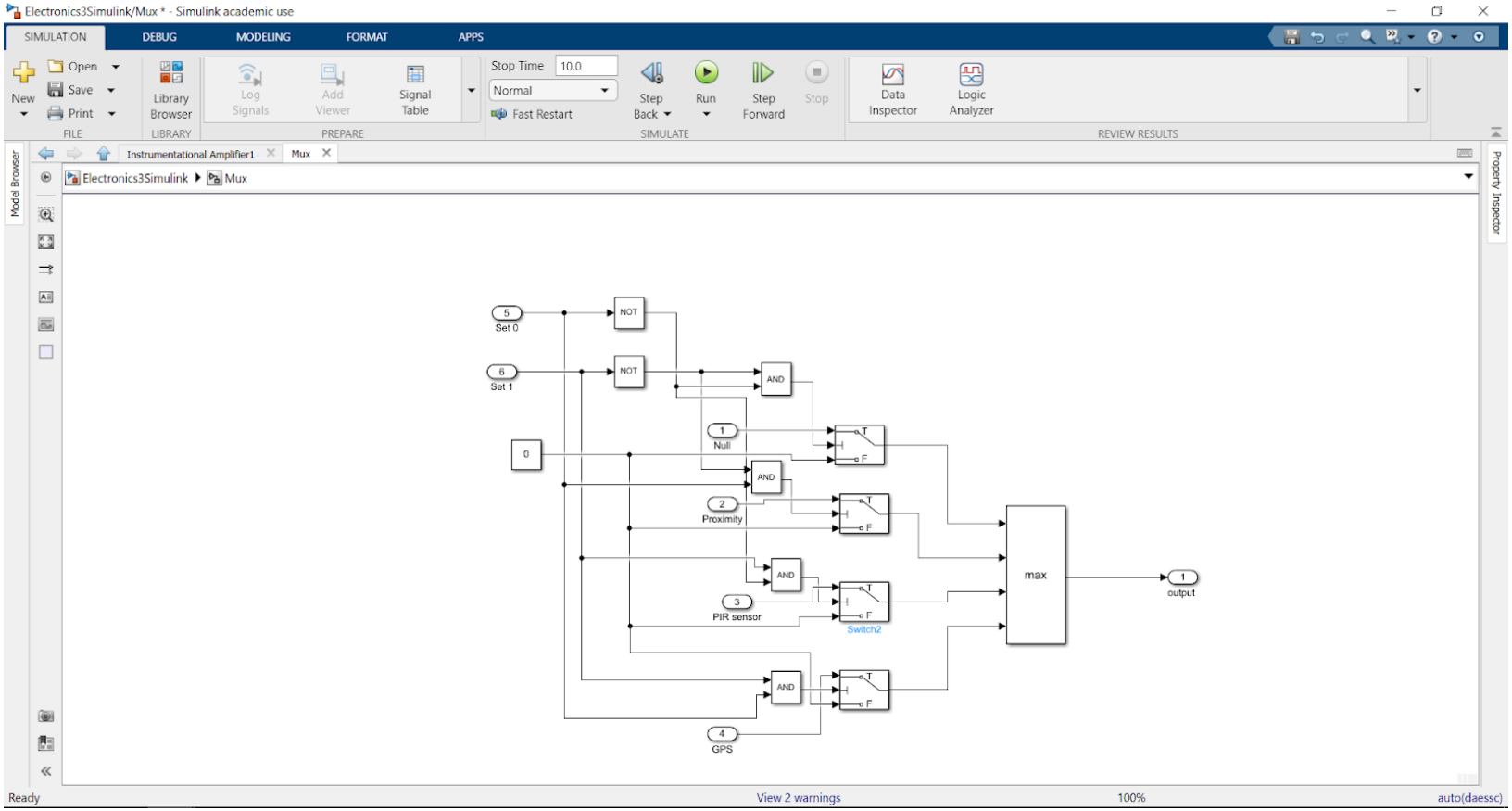
Filter

- Band Pass Filter is used in this simulation
- Benefit: eliminate noise and amplify the desired signal
- Blocking noise frequencies and passing signal in the desired frequencies



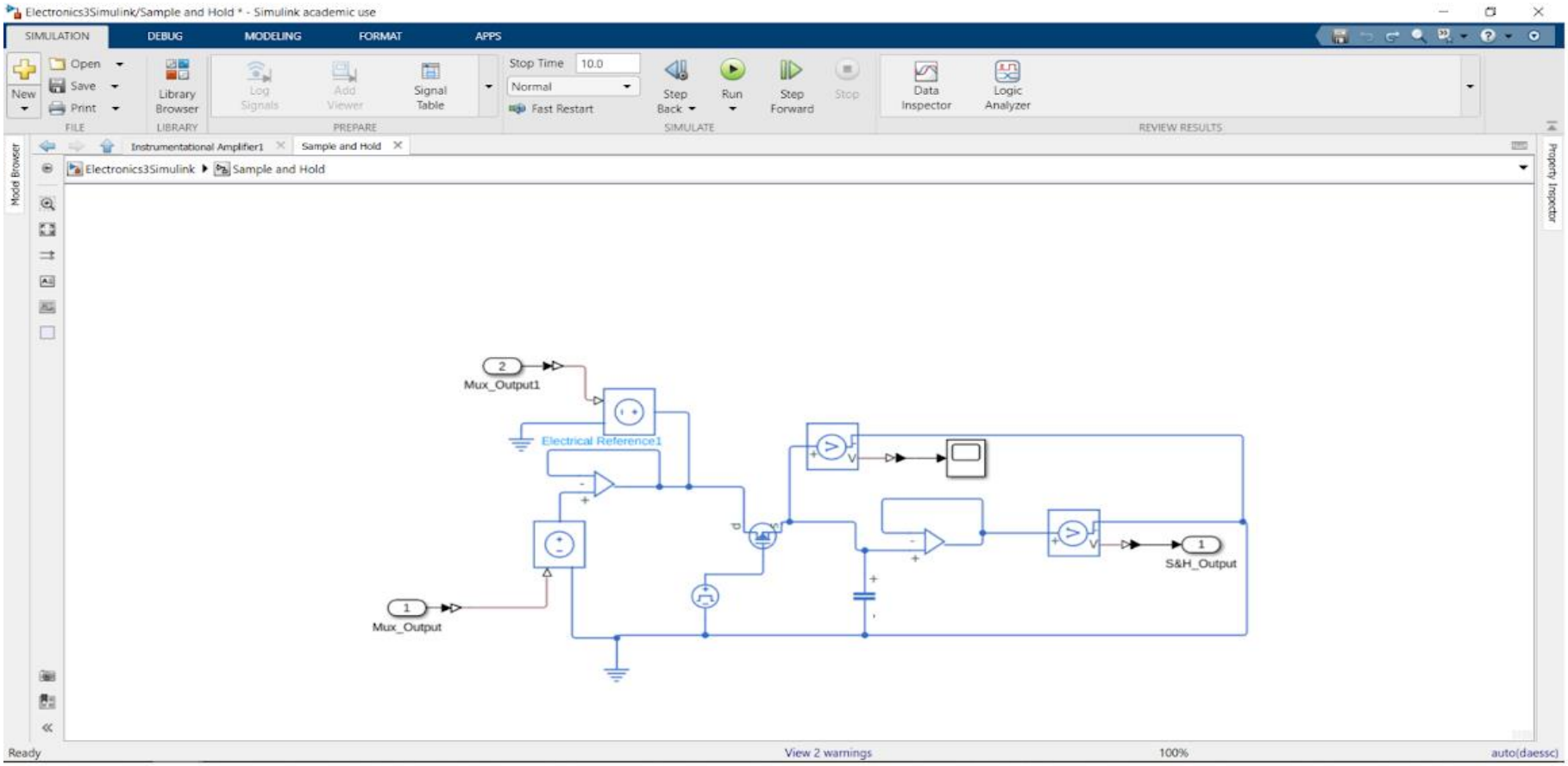
Multiplexer

- Connect one of the inputs to the output line based on the select signal
- The time at which each signal is passed through is determine by the code ad executed by the microcontroller (Raspberry Pi)



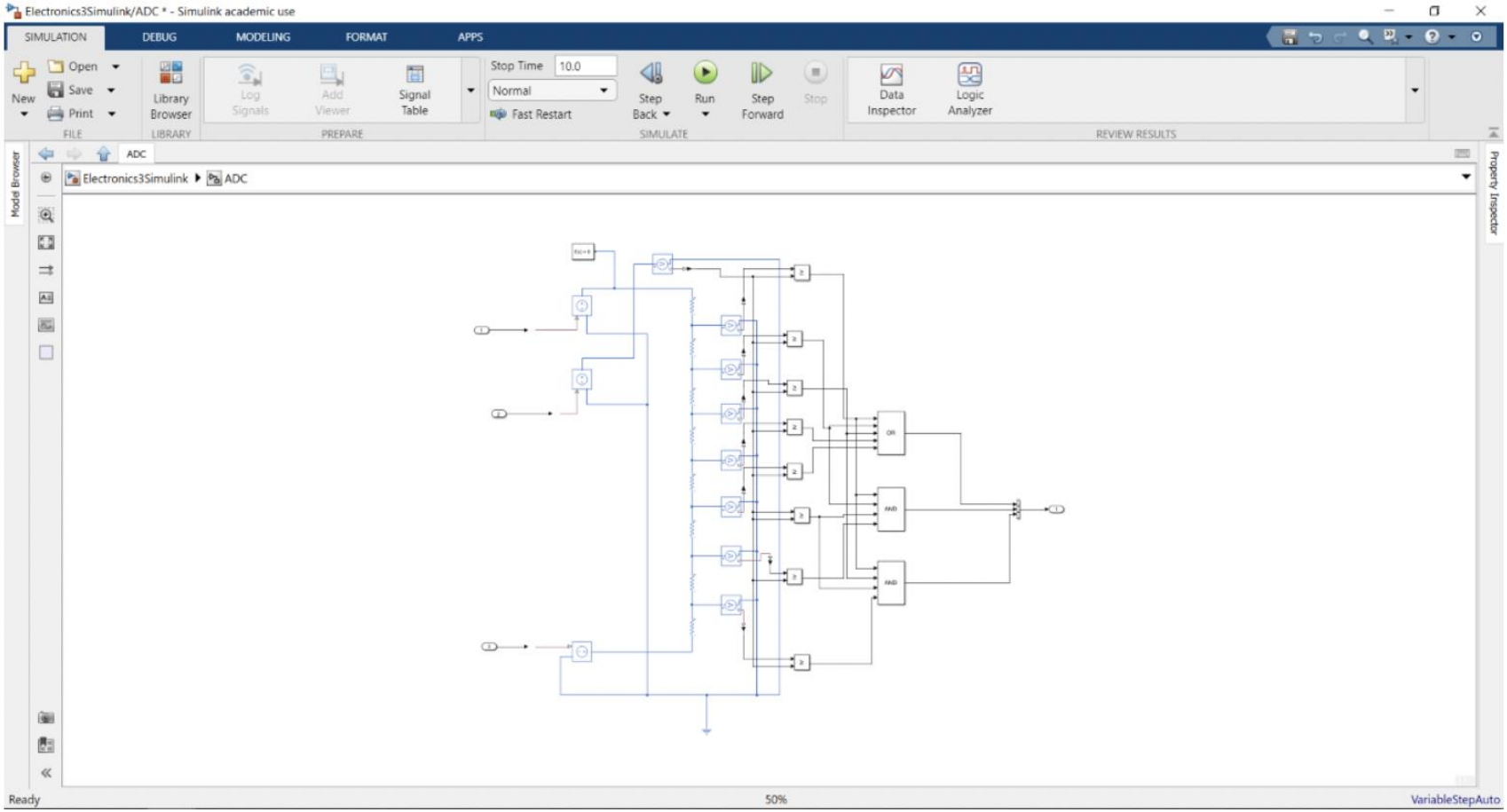
Sample and Hold

- Sample the given signal and hold the sampled value
- Used in combination with ADC to convert signal to digital



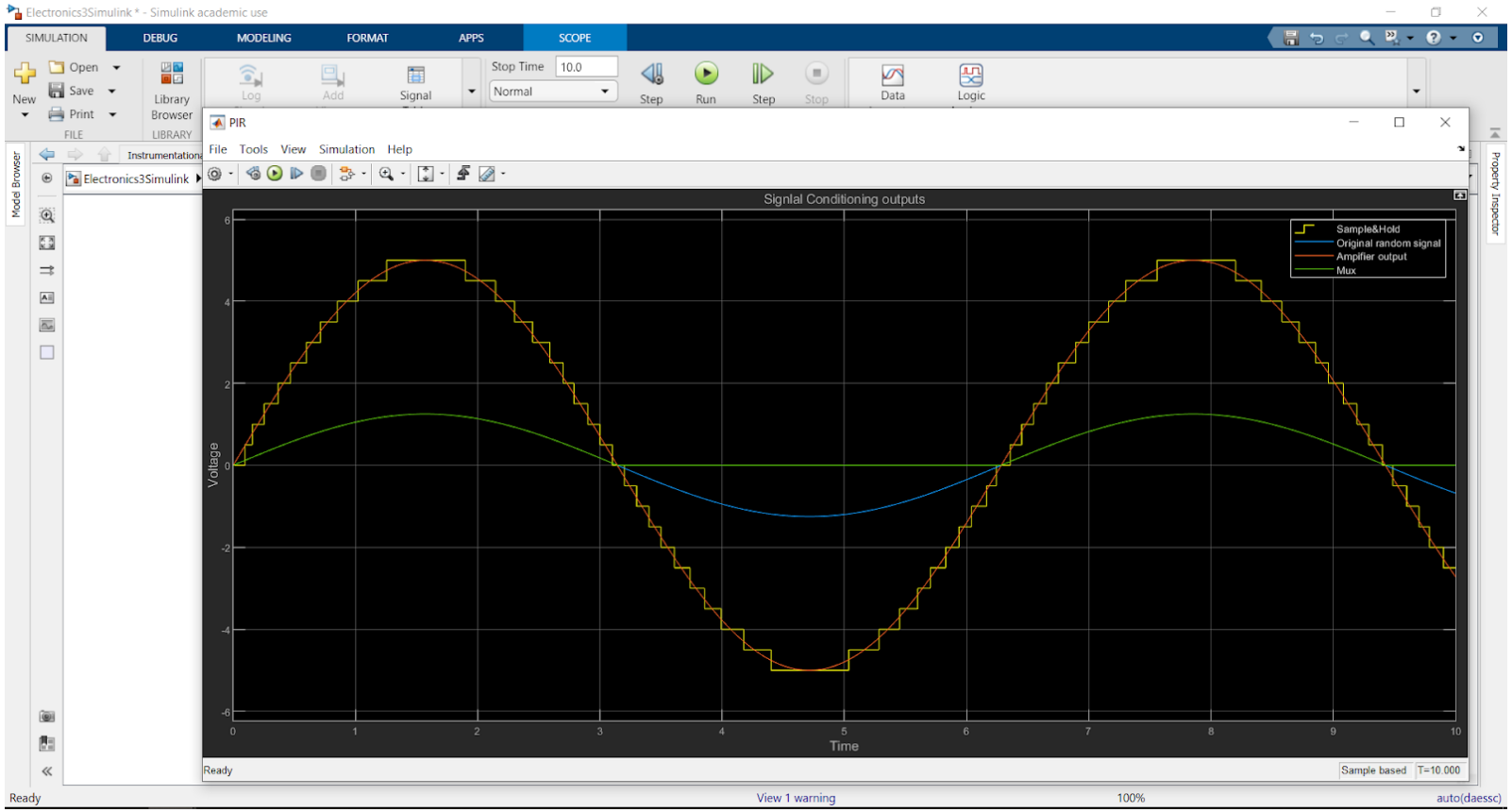
Analog to Digital Converter

- Two stages: S&H and Quantizer
- After the two stages the signal is Encoded into bits



Output Signal

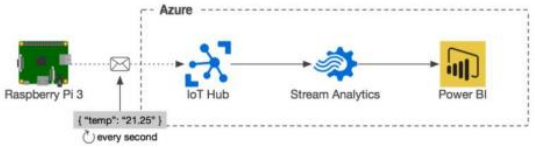
- Sensor signal at various steps of signal processing



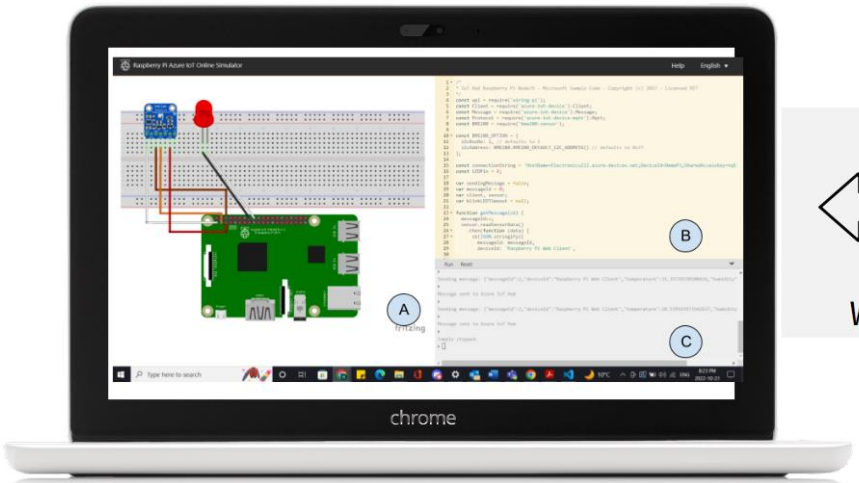
Simulation 2:

Purpose:

1. Explore Microsoft Azure IoT Hub
2. Test Python3 Code & Connection String
3. Read receive and display Data



Already talked about in more details in Midterm presentation



Gantt Chart

	Task Name	Duration	Estimated Date	Estimated Finish	% Complete	Task Owner	Task Depend on
1	Project Proposal	11 days	Sat 9/10/22	Fri 9/23/22	100%	Everyone	
2	Research and Gather Information	21 days	Fri 9/23/22	Fri 10/21/22	100%	Everyone	#1
3	**Initiation**	**5 days**	**Sat 10/15/22**	**Fri 10/21/22**	**100%**		
4	Project Charter	4 days	Sun 10/16/22	Wed 10/19/22	100%	Kaiyi Yuan	
5	**System Requirements Specification**	**39 days**	**Mon 10/17/22**	**Thu 12/8/22**	**100%**		
6	Midterm SRS	5 days	Mon 10/17/22	Fri 10/21/22	100%	Kaicheng Zhang	
7	Final and Detailed SRS	6 days	Thu 12/1/22	Thu 12/8/22	100%	Kaicheng Zhang	#6
8	**Planning**	**39 days**	**Sun 10/16/22**	**Thu 12/8/22**	**96%**		
9	Project Risks, Assumptions, and Constraints	4 days	Sun 10/16/22	Wed 10/19/22	100%	Josiah Bigras	
10	**Work Breakdown Structure**	**35 days**	**Mon 10/17/22**	**Fri 12/2/22**	**100%**		
11	Midterm Work Breakdown Structure	5 days	Mon 10/17/22	Fri 10/21/22	100%	Lidan Huang	
12	Trello board	2 days	Thu 12/1/22	Fri 12/2/22	100%	Lidan Huang	
13	Final Work Breakdown Structure	3 days	Wed 11/30/22	Fri 12/2/22	100%	Lidan Huang	#11
14	**Gantt Chart & Milestones**	**14 days**	**Sun 10/16/22**	**Thu 11/3/22**	**100%**		
15	Midterm Gantt Chart & Milestones	6 days	Sun 10/16/22	Fri 10/21/22	100%	Lidan Huang	
16	Final Gantt Chart & Milestones	1 day	Thu 11/3/22	Thu 11/3/22	100%	Lidan Huang	#15
17	**Project Cost estimate and Funding**	**35 days**	**Mon 10/17/22**	**Sun 12/4/22**	**100%**		
18	Midterm Project Cost estimate and Funding	3 days	Mon 10/17/22	Wed 10/19/22	100%	Kaiyi Yuan	
19	Final Project Cost estimate and Funding	4 days	Wed 11/30/22	Sun 12/4/22	100%	Lidan Huang	#18
20	**Risk Mangement Plan**	**34 days**	**Tue 10/18/22**	**Fri 12/2/22**	**100%**		
21	Midterm Risk Mangement Plan	4 days	Tue 10/18/22	Fri 10/21/22	100%	Josiah Bigras	
22	Final Risk Mangement Plan	6 days	Sun 11/27/22	Fri 12/2/22	100%	Josiah Bigras	#21
23	Controbution List	3 days	Tue 12/6/22	Thu 12/8/22	45%	Lidan Huang	

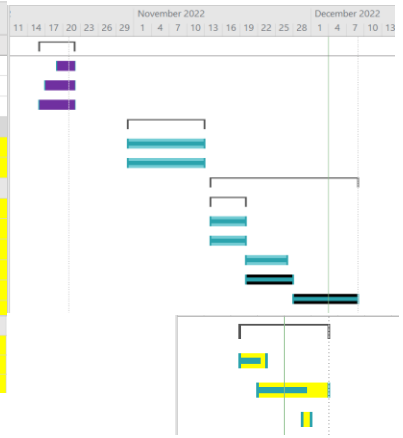
Highlight: Tasks improved and added after midterm.

Bar graph- Timeline display

Detail display on the left

Gantt Chart

	Task Name	Duration	Estimated Date	Estimated Finish	% Complete	Task Owner	Task Depend on
24	Conceptual Design	5 days	Sun 10/16/22	Fri 10/21/22	100%		
25	Hardware Specifications	3 days	Wed 10/19/22	Fri 10/21/22	100%	Kaiyi Yuan	
26	Software Specifications	5 days	Mon 10/17/22	Fri 10/21/22	100%	Nima Mehrjoonezhad	
27	Data Acquisition	6 days	Sun 10/16/22	Fri 10/21/22	100%	Nima Mehrjoonezhad	
28	Detail Design	10 days	Mon 10/31/22	Sat 11/12/22	100%		
29	Hardware Designing	11 days	Mon 10/31/22	Sat 11/12/22	100%	Kaiyi Yuan	#25
30	Software Designing	11 days	Mon 10/31/22	Sat 11/12/22	100%	Nima Mehrjoonezhad	#26
31	Testing and Debug	19 days	Mon 11/14/22	Thu 12/8/22	100%		
32	Test Plan	5 days	Mon 11/14/22	Sat 11/19/22	100%		
33	Hardware	6 days	Mon 11/14/22	Sat 11/19/22	100%	Kaiyi Yuan	#29
34	Software	6 days	Mon 11/14/22	Sat 11/19/22	100%	Nima Mehrjoonezhad	#30
35	Hardware Test	7 days	Sun 11/20/22	Sat 11/26/22	100%	Kaiyi Yuan	#33
36	Software test	7 days	Sun 11/20/22	Sun 11/27/22	100%	Nima Mehrjoonezhad	#34
37	Debug	9 days	Mon 11/28/22	Thu 12/8/22	100%	Nima Mehrjoonezhad	#36
38	Final	8 days	Tue 11/29/22	Thu 12/8/22	57%		
39	Post performance analysis	3 days	Tue 11/29/22	Thu 12/1/22	70%	Everyone	
40	Final Report	6 days	Thu 12/1/22	Thu 12/8/22	60%	Everyone	
41	Final Presentation	1 day	Tue 12/6/22	Tue 12/6/22	0%	Everyone	

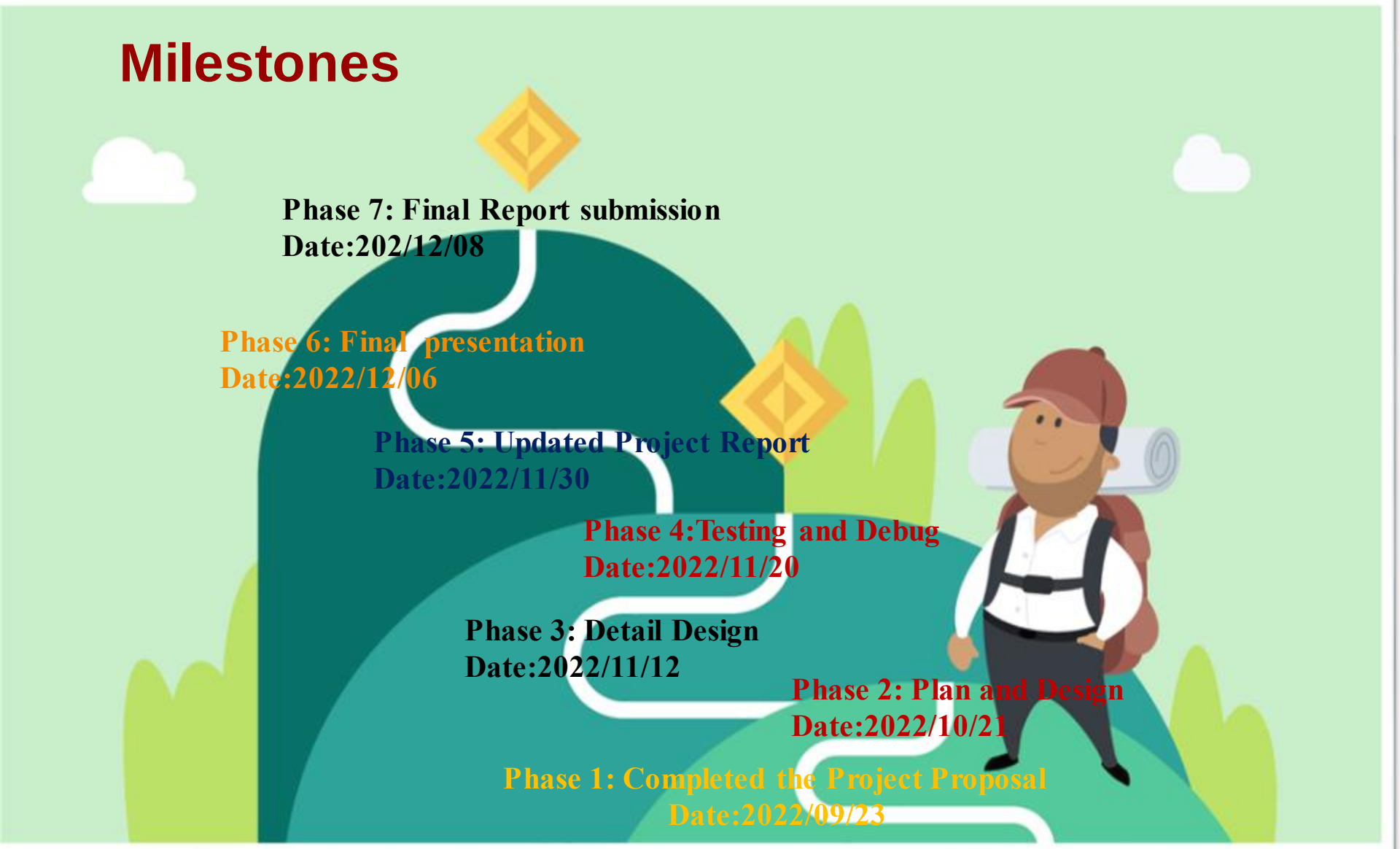


Highlight: Tasks improved and added after midterm.

Some part of the %complete are not 100%, which means that they had not been completed yet.

All tasks are expected to complete on December 8.

Milestones


Phase 7: Final Report submission
Date:202/12/08
Phase 6: Final presentation
Date:2022/12/06
Phase 5: Updated Project Report
Date:2022/11/30
Phase 4:Testing and Debug
Date:2022/11/20
Phase 3: Detail Design
Date:2022/11/12
Phase 2: Plan and Design
Date:2022/10/21
Phase 1: Completed the Project Proposal
Date:2022/09/23

Budget

Items	Price
18650 Battery*52	$260
Battery Management System	$12.99
Battery Insulator	$21.64
Raspberry Pi	$119.86
Heat Sensor	$22.05
Current Sensor	$12.99
Voltage Sensor	$10.20
Geekstory BN-220	$29.99
Capacitors	$16.99
Wires	$0
Total	$506.71

Reference List

Scully, D., *How to set and achieve project milestones in Teamwork Projects,* Project and Team Management Software,10 January.2019, https://www.teamwork.com/blog/how-to-set-and-achieve-project-milestones-in-teamwork-projects/

Iconbros. (n.d.),*Budget icon*, IconBros, Retrieved December 4, 2022, from https://iconbros.com/icons/ib-l-budget

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• J. Heath, "Can you ride electric scooter during winter?," Electric Wheelers, 06-May-2022. [Online]. Available: https://electricwheelers.com/can-you-ride-electric-scooter-during-winter/.