Excel-Word Assignment

Using Office Tools in Engineering

APSC 101/199: Problem Solving and Modeling

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1. Overview

This assignment is designed to ease your transition into university by ensuring you develop fundamental skills in using Microsoft Word and Microsoft Excel to create technical engineering documents. For this assignment, you are required to submit one Microsoft Word document, formatted according to the instructions, that includes calculations and graphs generated in Microsoft Excel. The formatting requirements of this document will be used throughout your first-year courses (particularly APSC 101, 102, and 103), and into your given discipline and career.

Sections 1, 2, and 3 of this document outline the submission and formatting requirements for this assignment that you will need to maintain for APSC 101 and 103. Sections 4, 5, 6, and 7 which correspond to Questions 1-4 introduce the background information and analysis required to complete each of the three questions included in this assignment. While the three questions may initially appear to focus on different engineering systems, they are intentionally designed around the three possible first-semester engineering design projects that you may encounter. Although each project focuses on a different application area, all three involve similar engineering concepts, including sensor measurements, automated systems, fluid dynamics, feedback systems, and decision-making under changing operating conditions. For this reason, it is important to develop a strong understanding of all three systems, regardless of which project you may ultimately work on during the semester. Additionally, this assignment introduces file organization practices that will help you manage and store course materials effectively throughout the term.

It is highly recommended that you complete the work for this assignment independently and use this as an opportunity to become comfortable working efficiently with both Microsoft Word and Microsoft Excel. The ability to organize reports, create professional figures and tables, perform calculations, analyze data, and communicate results clearly will recur throughout your engineering degree and learning it now will make your future coursework significantly easier.

1.1 Goals

In this assignment, you will use Microsoft Word and Microsoft Excel to learn various built-in tools to create detailed and professional reports, such as creating and linking tables/graphs, creating equations, using citations, and using proper formatting. By completing this assignment successfully, you should be able to:

1. Input experimental data into Microsoft Excel
2. Perform calculations in Microsoft Excel using manual input formulae and built-in functions
3. Generate simple and effective tables and graphs to describe experimental data in Microsoft Excel
4. Perform basic data analysis in Microsoft Excel, specifically regression and residual analysis as a part of laboratory error analysis
5. Properly format and organize a formal report in Microsoft Word

6. Integrate both graphs and tables created in Microsoft Excel into a report in Microsoft Word
7. Generate equations and sample calculations in Microsoft Word
8. Correctly reference resources used in a formal laboratory report using IEEE formatting
9. Critically evaluate experimental results on a basic level
10. Interpret engineering systems that rely on sensor measurements, automated monitoring, and feedback-based system responses
11. Organize course files using a structured file management system that can be accessed and maintained throughout the semester

This assignment will also introduce you to the engineering systems and design challenges that you will encounter in APSC 101 this fall, depending on the project stream assigned to your team.

1.2 Deadline

This assignment must be submitted as one Microsoft Word document and is due by 9:00am EST on September 8th, the first day of classes. Instructions for submitting the assignment will be provided the week before the deadline. Please note, this assignment requires the use of Microsoft Word and Microsoft Excel, which is free for all students. Graders will be reading the document using the desktop application of Microsoft Word, which often displays formatting slightly differently from documents created using the online app. If you use the online app to create the document, ensure that your formatting is correct in the desktop app before you submit the document.

1.3 Relevant Resources

Microsoft Word and Excel tutorials have been designed to help you and are available in text and video form here. Sections of these tutorial documents will be referenced for specific tasks. It is expected that you will read these resources and refer to them when completing the assignment.

Join us for a **Q&A Webinar** about the Excel Word Assignment on August 17th at 7:00pm EST. The meeting ID is 919 3732 0836 and the passcode is 865034. You can join the zoom call here.

If there are additional questions about the assignment, you may contact Areeba by email at a.saleem@queensu.ca for assistance until **August 24th**. If you email regarding issues with the software, you must have tried some troubleshooting on your own first. The internet is full of resources for Microsoft software. In your email, clearly describe what you have tried and what issues you are still having.

1.4 Required Software

This assignment can be completed on PCs, Macs, and online. The online version should be a last resort due to the errors in formatting mentioned above. You will need the following software and tools:

1. Download and install “Microsoft 365 Apps for Enterprise” from Queen’s University.
    a. https://portal.office.com/account
2. From 365, you will be using
    a. Microsoft Word – Ensure you have the option to use the IEEE reference style in the Word citation tool. Information on the citation tool and IEEE reference style can be found in the Microsoft Word Tutorial referenced in Section 3.
    b. Microsoft Excel – Ensure the “Analysis ToolPak” plug-in is installed in your version. Instructions are included in the Microsoft Excel Tutorial, referenced in Section 3.
3. Google Earth Web
    a. You will be required to use the web version of Google Earth as part of Section 5 (Question 2: Remote Hydroponic Horticulture System) to complete the site evaluation component of the assignment.

Ensure that the version that you are using for Word and Excel is the **most recent version**. You may have to remove old copies to update properly.

1.4.1 Troubleshooting Download Issues

Microsoft hosts a support portal to troubleshoot various issues which can be found here. Look for issues with ‘Microsoft 365’ rather than ‘Office XXXX’ (ex. Office 2021). If you encounter technical problems while installing or using the required software, there is a good chance that the issue has already been documented within Microsoft’s support resources. Remember that troubleshooting depends on what type of device you have, so make sure that you follow instructions appropriate for your device. Many Microsoft support pages default to Windows instructions unless macOS is specifically indicated. Note that if you have a Mac, one of the more common issues is activation, so look at those pages first.

2. Instructions

This assignment contains multiple datasets and engineering scenarios that you will need to work through Questions 1-4 (Sections 4-7) of this document. To complete the assignment, you will need to create tables and graphs in Microsoft Excel and import them into a properly formatted Microsoft Word Document. All tables, graphs, and equations generated in Microsoft Excel must be properly imported into the Word document and **must not be submitted as screenshots**. The only exception is Section 5 (Question 2), where a **Google Earth screenshot** will be required for the site evaluation component, and Section 7 (Question 4), where a screenshot of the required file structure will be required as part of the submission.

The only submission for this assignment will be one Word Document; **Excel files and PDFs or any additional files will *NOT be graded***. The specific formatting requirements are outlined in Section 3.

2.1 Saving and Uploading Your Work

Make sure you have a good system for saving and organizing your university work. All course files should be stored in a location that includes automatic backup and can be accessed from multiple devices such as your Microsoft OneDrive. Without a reliable system in place, important work can easily be lost. Loss of work due to poor file management will not be considered a valid reason for late submission.

Most students find that it is useful to have a single cloud folder for all academic work. It is strongly recommended that you create a folder in your Microsoft OneDrive for each course, named with the course code, e.g. “APSC 101”. In many cases it is helpful to have a subfolder within that folder if there are multiple files related to the same assignment, e.g., “Assignment 1 – Excel-Word”. You should also get in the habit of naming files with clear and searchable names. If there is a naming convention for an assignment, it is usually best to name the file in line with the convention right at the beginning, e.g. in this case the file you will have to submit will be named:

“STUDENT#_LASTNAME_FIRSTNAME_APSC101_ASSIGNMENT1.DOCX”

Ex. “12345678_Doe_Jane_APSC101_ASSIGNMENT1.DOCX”

When you submit your work to OnQ, always confirm that you receive a submission confirmation email. Before leaving the submission page, double-check that the correct version of your file has been uploaded and that the file format matches the submission requirements.

2.2 Important Academic Integrity Principles

DO NOT share your Word or Excel files with any other students. It is permitted to discuss and ask questions with other students, but ensure your work is all your own. If you share your work with other students, it may be considered an act of *facilitation* under the university’s Academic Integrity policy.

Every year there are students who start later and are tempted to use someone else’s work. Remember for all university assignments: **discuss, question, talk, and help each other, but do not share**. For more on academic integrity, please review: https://smithengineering.queensu.ca/about/policies-and-governance/academic-integrity.html.

2.2.1 Generative Artificial Intelligence (AI) Tools

Students must submit their own work and cite the work that is not theirs. Generative AI writing tools such as ChatGPT will be discussed later in the course, and we will be providing instructions on appropriate and effective use. Since the goal of this assignment is to ensure you are capable of formatting documents and conducting data analysis, use of generative AI tools is not allowed for this assignment and would constitute a Departure from Academic Integrity.

The only exception to this policy is Section 6 (Question 3: Biological Feedback Monitoring), where students are explicitly instructed to use an AI-based tool or chatbot as part of a citation comparison activity. Outside of this specific activity, the use of AI tools for completing this assignment is not permitted.

Note that if material in a submission is found to be produced by generative AI outside of the explicitly permitted activity in Section 6 (Question 3), it will not be graded.

3. Formatting Requirements

The following are the formatting requirements for the Word document submitted for this assignment. **Ensure you read them carefully before starting the Word document, while working on it, and again before you submit**. If you are unsure about a formatting requirement, return to this section and review the instructions provided. The requirements are listed in approximately the order that you will encounter while completing the assignment. Many of these formatting expectations will continue to appear in APSC 101, and 103. However, always refer to the instructions and requirements posted on OnQ for each course and assignment.

3.1 Filename

Your final report should be saved using the file naming convention provided in the assignment instructions. Proper file naming helps to make submitted work identified and organized correctly during grading. For this assignment, follow the format:

“STUDENT#_LASTNAME_FIRSTNAME_APSC101_ASSIGNMENT1.DOCX”

(Ex. 12345678_Doe_Jane_APSC101_Assignment1.DOCX)

3.2 Page Setup

The pages must have 1.0-inch margins (‘Normal’ setting) and 1.15 line spacing. All paragraphs, headers, text must be left justified, except for equations, and tables if necessary.

3.3 Text

- Paragraphs should not be indented
- Paragraphs should be separated by one line (1x ‘enter’)
- The end of a section should be separated by two lines (2x ‘enter’, so there is one empty line in

between)

- Body text should be size 11 Calibri font
- Text should be edited for spelling, grammar and concision

3.4 Title Page

- The title page should contain:
  - Course name (APSC 101)
  - Report name
  - Name and student number
  - Statement that all work in the report is written by the listed author except for properly cited material
  - Date submitted
- The title page should not have any embellishments or designs.
- See the practice solution example on the Excel Word Assignment website that can be found here.

3.5 Point of View

- Unless explicitly stated otherwise, all reports should be written in 3rd person (i.e. not using "I", "we", "our", "my") aside from reflections and descriptions of individual work.

3.6 Page Numbers

- Use Word's Header & Footer tool to insert page numbers at the top right side of the page
- There should be no page numbers on the title page
- Use Roman Numerals (i, ii, iii, etc.) for the page numbers for pages before the main body of the report (ie. Table of Contents, List of Figures, List of Tables)
- Use Arabic Numbers (1, 2, 3, etc.) beginning on the first page of the main body and for all subsequent pages (including appendices)
- To implement the different page numbers, you will need to use Section Breaks. Review the Microsoft Word Tutorial for how to do this.

3.7 Headings

- Use Word ***Styles*** to consistently format your headings for sections and subsections
- Each section should start with a number, ordered chronologically
- Each subsection adds an extra decimal place to the section number that it is housed in and uses the next smallest Heading style (6. (Heading 1) into 6.1 (Heading 2) into 6.1.1 (Heading 3), etc.)

- Within the section, the subsections should be ordered chronologically

3.8 Captions

- Include captions **below figures** and **above tables** using the Word ***Captions*** tool.
- Refer to each figure and table in the body of your report using **cross-referencing**, also found under the Word ***Captions*** tool. Use the "Only Label and Number" option when inserting cross-references such that the references appear as "Table 1" or "Figure 1" in the body of the report.
- The first reference of a Table or Figure should occur before the first time the Figure or Table is presented. Every Table or Figure **must be cross-referenced.**

3.9 Table of Contents

- The Table of Contents is intended to give your reader a quick and easy way to find any element of your report. As such, it should be an accurate listing of all sections in your report. Each section should be listed with its relevant starting page number next to it.
- Use Word's ***Table of Contents*** tool to generate a Table of Contents page from the headings.
- Word will automatically do this provided that the ***Styles*** tool was used for section headings.

3.10 List of Figures/List of Tables

- The captions and page numbers of all figures and tables in your report should be listed in a table following the Table of Contents on the same page. If your Table of Contents is almost a page in length, use the following page for the additional table.
- Use Word Captions to insert a List of Figures and List of Tables immediately after the Table of Contents, generated from the captions used in the report.
- The Table of Contents, List of Figures, and List of Tables should **not** be included in the Table of Contents.

3.11 References

- Use Word's ***Citations and Bibliography*** tool to insert in-text citations and add a References list to the end of Section 6 (Question 3). Make sure that it is a References list and not a bibliography, as references are used for citing works used to support the ideas/claims of a paper, while a bibliography is for background works or further reading
- Reference all external sources used throughout your work
- All citations must be in IEEE style
- In-text citations are mandatory wherever information from an external source is used.
- No citation management tools are perfect. It is always expected that you manually check

that your citations are generated in proper IEEE format and that you make all necessary adjustments.

- In Section 6 (Question 3: Biological Feedback Monitoring), you will compare references produced using different citation generation tools and evaluate whether they automatically follow IEEE formatting guidelines
- After completing the citation comparisons activity in Question 3, all final citations and references in your report should be inserted using Microsoft Word citation Manager, ensuring that any required formatting corrections have been made.
- You can find the IEEE Reference Guide **here** and should review it before beginning Section 6 (Question 3)

3.12 Equations

- Number all equations used in the body of the report.
- Any equations included should be referenced at least once by number in the report body before they are displayed.
- It is **not** expected that students use Word ***Captions*** to generate equation captions, cross-references, or a List of Equations.

3.13 Significant Figures

- Error values should be reported to one OR two significant figures. Make sure you remain consistent.
- Quantities associated with error should be taken to the same digit as the significant error digit. Example: 654.9 ± 0.8 or 654.93 ± 0.80
- If there is no error, unless otherwise instructed, report all numerical values to 2 decimal places.

3.14 Sample Calculations

- Include the generic form of the equation. Ensure the equation is numbered.
- Define all variables used in the equation.
- Report the final answer **with units.**
- A proper sample calculation has been modeled below and should be used as a formatting reference when presenting calculations throughout this assignment. When permitted in a specific report, you may be able to put the full calculation in an appendix and just use the general equation in the body of the report (the first line of the sample calculation below) with the given equation number (represented below with # as a placeholder). Appendices are used to display content that is not essential to the understanding of your work but provide relevant supplementary information that aids reader comprehension.
- The slope, m, can be used along with the y-intercept, b and the independent variable, x, to

calculate the response, y.

$$y = mx + b \tag{\#}$$

$$y = 4 \times 5 - 5$$

$$y = 15\ units$$

3.15 Units

- Report units in axis titles and at the top of table columns.
- When reporting units, ensure there is a space between the numerical value and the unit. Example: 25 mL not 25mL
- A space should not be left if the unit is percentages or degrees.

See the Microsoft Word Tutorial for instructions on how to properly implement all the above features into your reports. Review Section 8. to ensure you meet expectations.

3.16 Excel Formatting

Ensure that any tables and graphs that you are asked to include are linked to the Excel and are not screenshots. The only exception are figures that specifically require screenshots as part of the assignment instructions, such as Section 5 (Question 2) where a Google Earth screenshot is required for the site evaluation component, and Section 7 (Question 4) where a screenshot of the completed file structure is required as part of the submission. For formatting, follow the instructions provided in the Microsoft Excel Tutorial and adhere to the guidelines below.

For anything produced by Excel, you must use Calibri size 11. If a graph contains many individual data points and maintaining the default formatting makes the graph difficult to read, you can reduce to a minimum size of 9. Always use the correct significant figures as laid out in Section 3.13 Significant Figures. Tables and graphs should be scaled appropriately, so they remain fully legible and do not exceed the document margins. If necessary, tables and graphs that are too large to be legible may be placed in an appendix and cross-referenced.

For tables, columns should have appropriate headers with units and should maintain a professional presentation. This means maximizing whitespace, minimal colour, and minimal vertical and horizontal lines (borders). Any formatting choices, including borders or colour, should only be used when they improve readability.

For graphs, there are several components that must be included to keep up with a professional presentation. Error bars must be calculated correctly and should vary in length based on the uncertainty values calculated. Trendlines must represent the correct relationship required by the assignment (for example linear or polynomial), and the equation must be displayed on the graph clearly. The x and y in the auto-generated equation must be changed to appropriate variables. Axes must have appropriate titles with units, scaling to show the data as clearly as possible, and appropriate major tick mark scaling. Gridlines should be minimal but present for better legibility. Legends should be included, and they should overlap the plot (i.e. do not cover any of the data but they are within the borders of the plot itself). Markers and fonts should be of an appropriately legible size, and colour usage should be minimized for a professional presentation. Chart titles should **not** be included as all necessary information should be included in the caption of the graph.

3.17 Report Structure

For this assignment, you will submit **one complete Microsoft Word report** that documents the work completed for Questions 1-4 (Sections 4-7). The report should be structured as one cohesive document rather than as three separate submissions.

Your final report should contain the following major sections:

- Question 1 (Section 4): Drinking Water Filtration System
    - Results and Analysis
- Question 2 (Section 5): Remote Hydroponic Horticulture System
    - Results and Analysis
- Question 3 (Section 6): Artificial Pancreas Prototype
    - Results and Analysis
- Question 4 (Section 7): File Organization and Software Setup (a screenshot of the files)

For each question, the Results and Analysis subsection should present all technical work completed throughout the question. This includes calculations performed in Excel, processed data tables, graphs, equations, figures, sample calculations, and any other deliverables specifically listed within the question instructions. With the exception of the required screenshots in Section 5 (Question 2) and Section 7 (Question 4). **Excel generated tables and graphs must be inserted directly from your Excel and not submitted as screenshots.** Results should not simply be inserted without explanation. Throughout each section, short explanatory paragraphs should be included where required to interpret trends observed in the data, explain technical relationships, improve readability, and guide the reader through your analysis.

Throughout the report, ensure that all tables, figures, equations, calculations, and screenshots are properly captioned and introduced before they appear in the document. Use Microsoft Word captions and cross-referencing tools whenever referring to figures, tables, or equations within the body of your report. Equations should be properly numbered and referred to by equation number where appropriate.

Only refer to material included directly within your report, with the exception of properly cited external references. By extension, you should not refer directly to this assignment document.

4. Q1: Drinking Water Filtration System

Water treatment systems rely on continuous monitoring to ensure water remains safe for public use throughout the treatment process. One important parameter monitored is turbidity. Turbidity is a measure of the clarity of water due to the presence of suspended particles [1]. The particles will often make the water appear murky while they are suspended. Measuring turbidity is essential for various environmental and public health reasons, as high turbidity levels can indicate pollution, hinder aquatic life and complicate the water treatment process [1].

Turbidity sensors measure the opaqueness of water by transmitting light through the water, and capturing the reflected, scattered light with photodetectors [2]. The light is scattered by the particles found in the liquid, and as the amount of total suspended solids (TSS) increases the turbidity measurement increases, as shown in Figure 1 [2]. The photodetector then outputs a voltage which can be converted to Nephelometric Turbidity Units (NTU) [2].

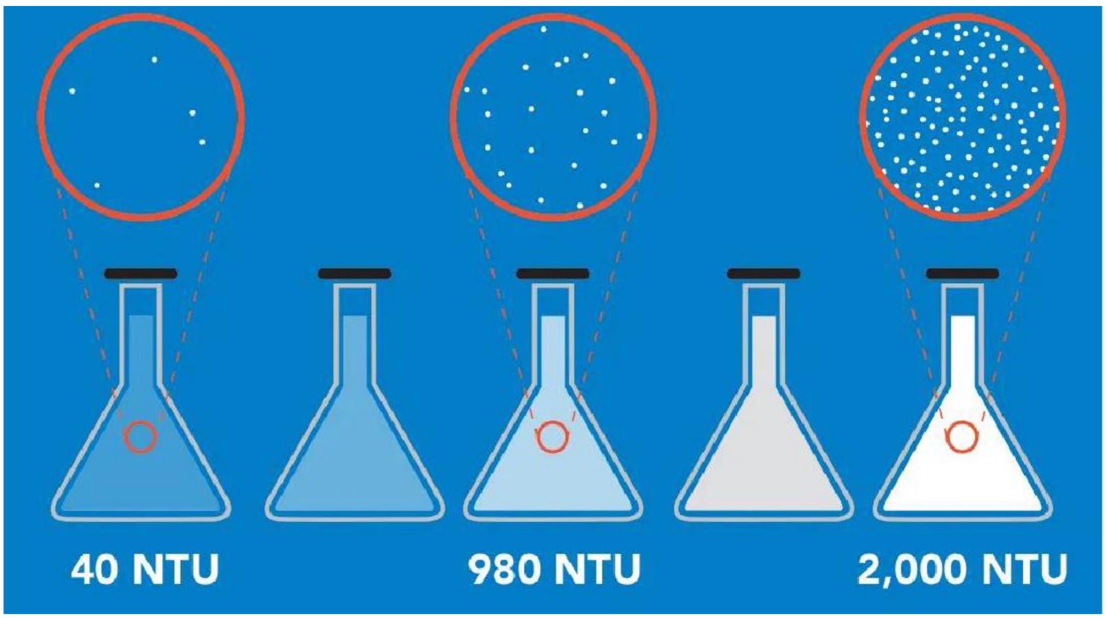


Figure 1: A series of water samples with increasing turbidity, indicated by the increasing NTU values, and the corresponding increasing particle concentration [2].

For this question, you are asked to analyze data collected from a turbidity sensor like the one provided in your kit. For more information on the turbidity sensors you will be using, check it out here [3].

4.1 Data

You will first use calibration data (Table 1) to determine the relationship between sensor voltage and turbidity. You will then use this relationship to analyze data collected from three turbidity sensors (Table 2) measuring the same water sample and investigate how differences in sensor calibration affect the results.

In Table 1, calibration was completed three times on a turbidity sensor, with known voltage readings producing measured turbidity values. The derived formula can be used to convert a sensor voltage reading to a corresponding turbidity value in NTU.

Table 1: The measured turbidity of water corresponding to turbidity sensor voltage readings

Voltage (V)	Calibration 1 (NTU)	Calibration 2 (NTU)	Calibration 3 (NTU)
4.25	0	0	0
4.05	350	700	625
3.55	1850	2000	1750
3.30	2400	2600	2500
3.00	2750	2900	2800
2.50	3050	3200	2950

Table 2 contains the first 10 rows of the data from settling tests using a mixture of bentonite clay and water after *alum* (aluminum sulphate) is added. Alum is a *coagulant,* which are materials made up of positively charged particles [5] that attract and form compounds with negatively charged material like bentonite clay [6]. These new compounds clump together as larger *flocs* and can then sink quickly to the bottom of the solution container [5].

The tests were conducted using three different turbidity sensors, all measuring the same water sample throughout the setting process. The sensors were intentionally calibrated differently. One was calibrated correctly, one was not recalibrated for this test and is slightly mis-calibrated, and one was deliberately uncalibrated (not necessarily in that order).

As you are completing your analysis, we will ask you to think about how calibration affects the data, and how calibration affects data output. Data collection may need to be done with uncalibrated tools in your labs throughout your degree and understanding how to identify and fix these issues is an essential skill to have.

Table 2: The first 10 rows of the Sensor Data showing the voltage readings in 250 mL water with 0.8 g of bentonite clay and 0.5 g of alum. The mixture was stirred for 60 seconds, then settled for 140 seconds. The full table to be used is in the Provided Data file.

Time (s)	Sensor 1 (V)	Sensor 2 (V)	Sensor 3 (V)
1	2.51	2.61	2.41
2	2.55	2.53	2.32
3	2.57	2.57	2.31
4	2.57	2.64	2.34
5	2.61	2.55	2.39
6	2.56	2.54	2.36
7	2.50	2.54	2.36
8	2.52	2.55	2.27

9	2.52	2.54	2.30
10	2.48	2.50	2.31

4.2 Steps to Follow

Important Submission Requirement: *Unless explicitly stated otherwise, all tables, graphs, plots, regression outputs, and calculations generated throughout this question must be inserted directly from Microsoft Excel or created using Microsoft Word tools where applicable. Screenshots are not permitted for any Excel-generated content in this question.*

1. Download the Excel file titled "Provided Data" from the website. Using the calibration data provided in Table 1 of the excel file, calculate the average turbidity for each voltage value using the built-in AVERAGE() function in excel. Calculate the maximum uncertainty for each value of the average turbidity using **Equation 1**.

$$turbidity\ uncertainty = \frac{sensor\ value\ with\ largest\ turbidity - sensor\ value\ with\ smallest\ turbidity}{2} \quad (1)$$

2. Display the new information in your report in a table with Voltage, Average Turbidity, and Uncertainty columns, and ensure to record the average turbidity values to the decimal place that aligns with its uncertainty as explained in Section 3.13 Significant Figures above.
3. Construct a scatter plot for the table you created in **Step 2** with **Voltage [V]** on the x-axis and **Turbidity [NTU]** on the y-axis. Only the average turbidity values need to be displayed on the graph. Include vertical error bars for the data points corresponding to the average calibration values with the uncertainty that you calculated in **Step 1**. Add a trendline that fits the average calibration data (a polynomial relationship) and ensure that the trendline equation with specific variables (i.e. not the default x, y variables used by Excel), and correlation coefficient (R^2) are displayed on the plot. Excel Tutorial 3 Data Visualization of the Microsoft Excel Tutorials walks through the process and there is an example of properly formatted scatter plot in the PDF version of the Microsoft Excel Tutorial. The trendline equation is important for further analysis, as it allows for any voltage value to be converted to its corresponding turbidity value, so be sure to include it in the results section of your report. After inserting the calibration graph into your report, include 2-3 sentences describing the relationship observed between voltage and turbidity and whether the calibration data appears to produce a reasonable sensor calibration model.
4. Using the full sensor data associated with Table 2 from your provided data file, use the formula of the trendline determined in **Step 3** to calculate the turbidity values for each of the three sensors. Calculate the average turbidity measurement of the three sensors and the maximum uncertainty of each of the average turbidity values using **Equation 1**.
5. Construct a scatter plot from the table you created in **Step 4** with **Time [s]** on the x-axis and **Average Turbidity [NTU]** on the y-axis; only plot the data between the time period of 70 to 95 seconds. This time period covers the majority of the settling time and is the best representation of how quickly the flocs are able to settle. Include vertical error bars for the

uncertainty that you calculated in Step 4. Error bars on a graph show the accuracy of measurements visually, as well as determining if a trendline is a good fit. If all the data points have error bars that cross the trendline path, then the trendline is a good representation of the data. Add a trendline that fits the data well, i.e. the R^2 value is as close to 1 as possible (linear relationship) and ensure that the trendline equation with specific variables and correlation coefficients are displayed on the plot. After inserting the graph from **Step 5**, include 2-3 sentences describing the relationship observed between time and turbidity and explaining what the trend suggests about particle settling behaviour during the filtration process.

6. For the data graphed in **Step 5**, use **Regression** in excel to perform a regression analysis using columns from the table you created in **Step 4**. The use of a regression analysis can show whether a strong relationship between the dependent and independent variables exists and gives data on that relationship. For the linear regression performed here, this information includes slope and y-intercept. Please refer to [Excel Tutorial 4 Data Analysis](), which describes how to conduct a regression analysis and analyze the residual plots. To complete your regression analysis, you must first select the set of data you want to analyze. The graph from **Step 5** shows a linear relationship, therefore the input X range for the regression analysis should be the **Time [s]** column and the input Y range should be the **Average Turbidity [NTU]** column. After selecting your data, ensure you check the summary statistics box and use a **68% confidence level,** where the value 68 comes from 68% of a normal data point density being within ± one standard deviation (variation or uncertainty) of the mean. Be sure to check the box for **Residual Plots** so that it will generate that plot. After presenting the residual plot, include 2-3 sentences commenting on whether the residuals suggest that the trendline is a reasonable fit and whether any possible experimental error or outliers are visible in the data.
7. Summarize your findings clearly with the data from the **Coefficients** and **Standard Error** columns from the regression analyses. Include the Residuals plot with error bars for the data in your report and comment on whether you believe the plot supports the relationship that you suspected. Guidelines for this analysis are found in the video [Excel Tutorial 4 Data Analysis]().
8. Based on your summary from **Step 7**, propose an equation to describe the relationship between time and turbidity for the graph. Use the **Equation** option in Word. Outline this equation using the Sample Calculation format outlined in Section 3.14 Sample Calculations.

*Hint: the regression analysis that you did in **Step 6** provided results to describe a linear relationship in the form of Equation 2 where x is the input X range, y is the input Y range, m is the slope, and b is the y-intercept.*

$$y = m \times x + b \tag{2}$$

9. Construct a line plot showing each individual sensor from the data you pulled in **Step 4** (*not* the average turbidity) with **Time [s]** on the x-axis and **Turbidity [NTU]** on the y-axis. You should have three lines on one graph, and this will cover the full 1-200 data points. There should be no error bars on this graph. After presenting the graph from Step 9, include one short paragraph identifying which sensor appears properly calibrated and which sensors may be uncalibrated.

Briefly explain how differences in calibration may affect measurements and suggest one possible reason why sensor calibration may drift over time.

4.3 Required Work for Submission

4.3.1 Results and Analysis

This subsection should present all calculations, tables, figures, equations, and analysis generated throughout Question 1. Throughout this section, short explanatory paragraphs should be included after major figures or analyses where necessary to interpret trends observed in the data, comment on measurement uncertainty, and explain the significance of the results obtained. Results should not simply be inserted without explanation.

The results to be included are:

- 2 tables showing the provided data
- 1 table showing the calibration average and uncertainty, from **Step 2**
- 1 scatter plot showing the relationship between voltage and turbidity from **Step 3**
- 2-3 sentences discussing the relationship observed between voltage and turbidity and whether the calibration data produces a reasonable sensor calibration model
- 1 sample calculation, for turbidity from voltage, from **Step 4**
- 1 table with the mixture's converted turbidity values, average turbidity, and uncertainty from **Step 4**
- 1 scatter plot showing the relationship between time and turbidity from **Step 5**
- 2-3 sentences describing the relationship observed between time and turbidity and explaining what the trend suggests about particle settling behavior during the filtration process
- 1 residual plot from regression analyses from **Step 6**
- 2–3 sentences commenting on whether the residual plot suggests the trendline is a reasonable fit and whether any possible outliers or experimental error are visible
- 1 summary table with the trend data from the regression analyses from **Step 7**
- 1 equation that describes the data from **Step 8**
- 1 line plot showing the converted turbidity values from all three sensors from **Step 9**
- 1 short paragraph identifying which sensor appears properly calibrated, which sensors may be uncalibrated, and how calibration differences may affect measurements

The order of the results above is the recommended order for your report, but other orders are acceptable provided that all the information has been presented clearly and the report still flows logically.

5. Q2: Remote Hydroponic Horticulture System

Hydroponics is a way of growing plants without using soil, instead delivering water and nutrients straight to the roots. Because these systems allow greater control over growing conditions, they are often used in areas where traditional farming is harder due to poor soil conditions, limited space, harsh climates, or limited resources [4].

To maintain healthy growth, hydroponic systems must carefully monitor water conditions and keep nutrient levels within suitable ranges. Two important parameters often measured are pH and Total Dissolved Solids (TDS). pH measures how acidic or basic the solution is, while TDS represents the amount of dissolved nutrients in the water. If either value falls outside the desired range, plants may not be able to absorb nutrients effectively [5].

pH sensors determine the acidity or basicity of a liquid by measuring the concentration of hydrogen ions present in a solution. Chemical reactions in the sensors generate electrical signals, which are then interpreted and displayed as pH values. Automated hydroponic systems use these sensors to monitor system conditions and determine when adjustments are required. For example, if nutrient concentration falls below a target value, an additional nutrient solution may need to be added, while pH outside an acceptable range may require chemical adjustment [6].

For this question, you are asked to analyze data collected from a pH sensor similar to the one used by teams working on the hydroponic growing prototype. For reference, most hydroponic systems operate best within a pH range of approximately 5.5–6.5 [7]. For more information on hydroponic growing systems and pH sensors, check here [8].

5.1 Data

Table 3 contains experimental data collected while observing changes in pH after increasing amounts of white vinegar (5% acetic acid) were added to 100 mL of deionized (DI) water.

After each amount of vinegar was added, the solution was allowed to sit for one minute so the pH could stabilize before measurements were taken. Once stable, pH readings were recorded once every second over a 10 second period. Multiple measurements were collected because sensor readings can fluctuate slightly even when the surrounding conditions remain unchanged. Repeating measurements makes it possible to calculate an average value and estimate the uncertainty associated with the collected data.

In automated hydroponic systems, pH sensors are used to monitor the nutrient solution and detect changes over time. As the solution changes, the sensor's pH readings will change accordingly. As you complete your analysis, think about how these changing readings reflect what is happening in the system, how repeated measurements can help account for uncertainty, and why accurate sensor data is important when designing systems that rely on continuous monitoring.

Table 3: The first five experimental pH measurements collected after increasing amounts of vinegar were added to 100 mL of DI water. Multiple measurements were recorded at each vinegar addition, and the complete dataset is provided in the Excel file.

Vinegar Added (mL)	pH Measurement 1	pH Measurement 2	pH Measurement 3	pH Measurement 4	pH Measurement 5
0	6.11	6.10	6.11	6.09	6.07
1	3.23	3.23	3.23	3.24	3.23
2	3.08	3.07	3.08	3.08	3.08
3	3.00	3.00	3.00	3.00	3.00
4	2.93	2.92	2.92	2.93	2.93

5.2 Steps to Follow

5.2.1 Part A: pH Sensor Data Analysis

Important Submission Requirement: *Unless explicitly stated otherwise, all tables, graphs, calculations, and other Excel-generated content throughout this question must be inserted directly from Microsoft Excel and must not be submitted as screenshots. The only exception in this question is the required Google Earth site evaluation component, where a screenshot of the final annotated site is required.*

1. Similar to what was done for question 1, use the provided data on the Excel file associated with Table 3. For each vinegar addition level, calculate the average pH using the built-in AVERAGE() function in Excel. Calculate the maximum uncertainty for each average pH value using Equation 2.

$$pH\ uncertainty = \frac{sensor\ value\ with\ largest\ pH - sensor\ value\ with\ smallest\ pH}{2} \qquad (2)$$

2. Display the new information in your report in a table with Vinegar Added (mL), Average pH, and Uncertainty columns. Ensure that the average pH values are recorded to the decimal place that aligns with their uncertainty, as explained previously in Section 3.13 Significant Figures.
3. Construct a scatter plot for the table created in Step 2 with Vinegar Added (mL) on the x-axis and Average pH on the y-axis. Only the average pH values need to be displayed on the graph. Include vertical error bars for the data points corresponding to the uncertainty values calculated in Step 1. Add a trendline that best fits the data and ensure that both the trendline equation and correlation coefficient (R^2) are displayed on the graph. Excel Tutorial 3 Data Visualization provides an example of how to properly format scatter plots, error bars, and trendlines in Excel.
4. After inserting the graph into your report, include one short paragraph describing the relationship observed between vinegar addition and measured pH, what the uncertainty values

suggest about the consistency of the measurements collected, and why accurate pH measurements are important in automated systems that rely on continuous monitoring.

5.2.2 Part B: Site Evaluation

Before implementing any engineering system, it is important to understand the conditions of the environment in which that system will operate. For hydroponic growing systems, surrounding environmental conditions may influence whether controlled food production is a practical alternative to conventional agriculture. In this section, you will use a geographic mapping tool to examine a proposed site and assess factors that may influence system design.

1. Open the web version of Google Earth and create a new project. Navigate to the following coordinates**: 24.4372, 54.6148**. Once the location has loaded, adjust the map view so that the surrounding environment can be clearly observed. You may zoom in or out as needed, however the final map view should not extend beyond approximately **5 km** from the selected site. You are encouraged to adjust the zoom level to ensure that the physical and environmental features you identify remain clearly visible and can be easily distinguished in the final screenshot.
2. Using the annotation tools available in Google Earth, identify and clearly label three physical or environmental features that may influence the design or operation of a hydroponic growing system.
    - Features may be annotated using tools such as: placemarks, paths or lines, polygons or custom shapes
    - Ensure annotation colours, line thickness, and labels are clearly visible in the final image. After creating annotations, you may need to adjust the map view so that all selected features are visible within a single screenshot. If needed, use the Zoom to Fit option by locating the feature in the left-hand project panel, clicking the three dots beside the feature name, and selecting Zoom to Fit. This will automatically adjust the map view to center the selected annotation and may help when preparing the final screenshot.
    - Examples of features that may influence engineering design decisions include, but are not limited to:
        - Nearby water sources or water infrastructure
        - Terrain conditions
        - Access roads or transportation infrastructure
        - Surrounding land use
        - Nearby utility infrastructure
        - Existing buildings or industrial facilities
    - For an example of how to approach this type of site evaluation and annotation process, review the **"Monarch Habitat Evaluation Activity"** section of this video. You do not need to watch the full video, however skimming 7:30 -13:52 may be helpful.

3. Once completed, take a screenshot of the final annotated site and insert it into your report. The screenshot must include the map display with the annotations and left-hand project sidebar showing all created features
4. After inserting the annotated Google Earth screenshot into your report, include one short paragraph explaining why the three selected physical or environmental features may influence engineering decisions related to hydroponic system design and whether hydroponic growing systems may provide advantages over traditional agriculture at this location based on the site conditions observed.

5.3 Required Work for Submission

5.3.1 Results and Analysis

This subsection should present all calculations, tables, figures, equations, screenshots, and analysis generated throughout Question 2. Short explanatory paragraphs should be included after major figures or analyses to interpret trends observed in the data, comment on measurement reliability, and explain the engineering significance of the results obtained. Results should not simply be inserted without explanation.

The results to be included are:

- 1 table showing the provided experimental pH data
- 1 table showing the calculated average pH values and uncertainty, from **Step 2**
- 1 scatter plot showing the relationship between **Vinegar Added (mL)** and **pH**, including the trendline equation from **Step 3**
- 1 short paragraph discussing the relationship observed between vinegar addition and pH, what the uncertainty values suggest about measurement consistency, and why accurate pH measurements are important in automated monitoring systems
- 1 annotated Google Earth screenshot showing the selected site, including three labeled physical or environmental features
- 1 short paragraph explaining how the selected site conditions may influence hydroponic system design decisions and whether hydroponic growing systems may provide advantages over traditional agriculture at this location

The order of the results above is the recommended order for your report, but other orders are acceptable provided that all the information has been presented clearly and the report still flows logically.

6. Q3: Artificial Pancreas Monitoring

Many engineering systems rely on closed feedback loops to continuously monitor changing conditions and automatically respond to maintain stable operating conditions. A closed feedback loop consists of a system that measures an output condition, compares that measurement against a desired operating range, and performs corrective actions when changes occur. Examples include the systems examined in the previous two questions. Similar feedback systems exist naturally within the human body, where organs continuously monitor internal conditions and trigger biological responses that help maintain stability.

Additionally, in engineering and technical writing, information gathered from external sources must be properly referenced within the text to identify the source of that information. This question introduces the use of IEEE referencing, which is detailed in Section 3.11.

6.1 Steps to Follow

Important Submission Requirement: *All citations, references, written analysis, and other report components completed throughout this question must be created directly within Microsoft Word using the required formatting tools where applicable. Screenshots are not permitted for citation generation activities. The only exception is the block diagram, which may be hand drawn or digitally created and then inserted into the report.*

1. Research how the pancreas regulates blood glucose concentration in the human body. This is an example of a closed feedback loop, where changing conditions are continuously monitored and biological responses occur to restore stability.
2. Conduct research using reliable external sources to understand how the pancreas monitors changing conditions and responds to regulate internal body conditions. You may use multiple sources during your research process; however, for the citation comparison activity in the next step, you will select one source that will be used consistently throughout the comparison process.
3. Citation management tools frequently generate references automatically; however, automatically generated references do not always follow proper formatting conventions. Select one source used during your research and create references for that same source using three different methods:
    - Generate one reference using an AI-based tool or chatbot
    - Generate one reference using a non-AI citation generation tool such as Zotero, MyBib, or another citation generator
    - Manually enter the source information into Microsoft Word Citation Manager and allow Word to create its own reference entry
4. Compare all three references against the IEEE Reference Guide (section 3.11) provided with this assignment. Identify formatting differences between the three versions and determine what

corrections may be required for each. This activity is intended to demonstrate that automatically generated references should always be manually checked for formatting accuracy.

5. Write one paragraph explaining how the pancreas functions as a closed feedback loop. Your explanation should clearly identify:
    - the changing internal condition being monitored
    - the biological sensing or detection mechanism
    - the control action that occurs in response
    - the resulting physiological response
    - the condition the biological system is working to regulate
6. Review the paragraph written in Step 5 and insert IEEE in-text citations throughout the paragraph, referring to the Microsoft Word Tutorial Reference Guide. Citations should appear immediately after any sentence or idea that relies on information gathered from external sources. If multiple consecutive sentences all derive from the same source, one citation may cover them as long as authorship/source attribution remains unambiguous. Repeat the citation whenever ambiguity could arise.
7. Create a simple block diagram that models the pancreas as a closed feedback loop based on the information gathered during your research. It can be drawn neatly on paper or digitally using a tablet. The diagram should clearly identify:
    - System input
    - Sensor or detection mechanism
    - Control action
    - System response
    - Condition being regulated
8. Based on what you learned during the citation comparison activity in Step 3, use Microsoft Word Citation Manager to create a correctly formatted IEEE reference list containing all external sources used throughout your research. Ensure that each reference has been manually checked for formatting accuracy using both the IEEE Reference Guide and Microsoft Word Tutorial Reference Guide. All in-text citations included throughout your paragraph should correspond to entries listed in the final reference list in IEEE format.

6.2 Required Work for Submission

6.2.1 Results and Analysis

This subsection should present all written analysis, figures, references, diagrams, and supporting work generated throughout Question 3. Short explanatory paragraphs should be included where necessary to introduce content, explain technical concepts, and improve readability throughout the section.

The results to be included are:

- 1 reference automatically generated using an AI-based tool or chatbot

- 1 reference generated using a **second non-AI** citation generation tool of your choice (for example Zotero, MyBib, or another citation generator)
- 1 reference created using Microsoft Word Citation Manager
- A brief comparison identifying formatting differences observed between **all three references** and any corrections required after comparison with the IEEE Reference Guide
- 1 paragraph explaining pancreas as a closed feedback loop, containing properly formatted IEEE in-text citations inserted using Microsoft Word Citation Manager
- 1 block diagram representing the pancreas as a closed feedback loop
- 1 final correctly formatted IEEE reference list generated using Microsoft Word Citation Manager containing all sources used throughout the research process

The order of the results above is the recommended order for your report, but other orders are acceptable provided that all the information has been presented clearly and the report still flows logically.

7. Q4: File Organization and Management

As a first-year engineering student, you will typically have 6 or 7 unique courses each term. Throughout your courses, you will regularly use Queen's University's Learning Management System, called OnQ, to access course materials, assignments, and lab documents.

In APSC102, you will frequently download files from OnQ for weekly labs and course activities. Many students leave all downloaded files in their Downloads folder, but over time this can become disorganized and make it difficult to locate important course materials. Good computer maintenance practices involve creating an organized filing system and sorting downloaded files into clearly labeled folders and subfolders.

For APSC102, you are required to create and organize a folder structure directly on your computer to manage course materials effectively.

7.1 Steps to Follow

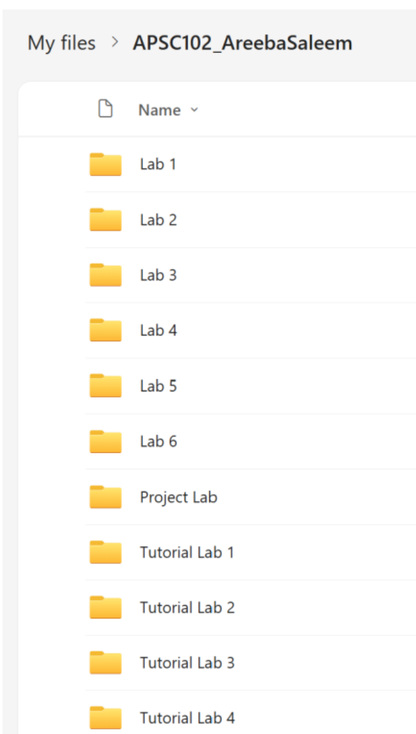
1. On a Windows computer, open File Explorer by clicking the folder icon on the taskbar or pressing: Windows Key + E. If using a Mac, open Finder.
2. Select an online cloud-based storage location where you want to store your course files. This must be a location that allows your files to be accessed from any computer, such as OneDrive. Ensure that your files are properly syncing to your computer before continuing.
3. Create a new folder for the course, include your name in the folder name: “APSC102_YourName”
4. Open the course folder and create all required subfolders:
    a. Tutorial Lab 1

b. Tutorial Lab 2
c. Tutorial Lab 3
d. Tutorial Lab 4
e. Lab 1
f. Lab 2
g. Lab 3
h. Lab 4
i. Lab 5
j. Lab 6
k. Project Lab

7.2 Required work for submission

For this question, include the following in your report:

1. Take a screenshot (example below) showing the completed folder structure. The screenshot must clearly display:
    a. The main course folder (APSC102_YourName)
    b. All required subfolders listed below



References

[1] D. O'Donnell, "Understanding the Science Behind Turbidity Sensors and How They Work," *Sensorex*, Sep. 13, 2021. Accessed: Jun. 15, 2026. [Online]. Available: https://sensorex.com/understanding-the-science-behind-turbidity-sensors-and-how-they-work/.

[2] "What is a Turbidity Sensor," *AtlasScientific,* Aug. 2, 2023. Accessed: Jun. 15, 2026. [Online]. Available: https://atlas-scientific.com/blog/what-is-a-turbidity-sensor/.

[3] "Gravity: Analog Turbidity Sensor for Arduino," *DFRobot*, Dec. 17, 2015. Accessed: Jun. 15, 2026. [Online]. Available: https://www.dfrobot.com/product-1394.html.

[4] G. Niu and J. Masabni, "Hydroponics," in *Plant Factory Basics, Applications and Advances*, London, U.K.: Elsevier, 2022, pp. 153-166.

[5] GrowGeneration, "pH for Hydroponics: Why It Matters and How to Balance It," *GrowGeneration,* 2026. Accessed Jun. 15, 2026 [Online]. Available: https://www.growgeneration.com/blog/ph-for-hydroponics.

[6] H. Sulaiman, "Automated Hydroponic Nutrient Dosing System: A Scoping Review," *AgriEngineering,* vol. 7, no. 2, Art. no. 43, 2025.

[7] G. Rajaseger *et al*., "Hydroponics: Current Trends in Sustainable Crop Production," *Bioinformation,* vol. 19, no. 9, pp. 925–938, 2023.

[8] S. Joshua, "Water Quality Monitoring and pH Sensors in Hydroponic Gardening," *Sensorex*, Oct. 14, 2024. Accessed 15 June 2026. [Online]. Available: https://sensorex.com/hydroponic-gardening/..

8. Grading

This assignment is part of APSC 101/199 to demonstrate appropriate preparation for engineering communications. The courses are competency based and do not use a traditional weighted average grading system, but the completion of this assignment will be the equivalent of 1-2% of a final grade.

8.1 Submission Instructions

This assignment is due by **Tuesday Sept. 8 at 9am EST.** Instructions for submission will be provided the week before it is due.

The submission made for this assignment *must* be a Word document; no other formats will be marked.

8.2 Late Penalty

APSC 101 is preparing you for engineering practice, including managing time effectively and meeting deadlines. One of the required competencies we will be evaluating in APSC 101 is *Professional Practice*, and repeated late submissions will impact your evaluation for *Professional Practice* in the course. Additionally, a submission received after 5 days from the posted deadline will not be graded.

8.3 Marking

You must complete all of the assignment questions. Submitting an incomplete assignment will result in receiving a grade of zero.

There are two components to the total mark you will receive for this assignment.

1. The “Word” component, pertaining to the presentation of your Microsoft Word work, will be marked out of **16**.

2. The “Excel” component, pertaining to your data analysis in Microsoft Excel, will be marked out of **14**.

3. The “Questions” component, pertaining to the content of the Questions, will be marked out of **5.**

Please carefully review the marking rubrics for all sections.

8.4 Marking Rubric – Word

Please note that all of the assignment questions must be completed. An incomplete assignment will receive a zero.

	2 • **very clear** • **properly formatted using appropriate function in Word**	**1** • **understandable** • **properly formatted, but not with appropriate functions in Word**	**0** • **unclear** • **improperly formatted missing**	**Mark**
• **Title Page** • **Page Numbering**	• Page numbers present and correct, created using Word functions	• Page numbers are present, but have been created manually	• Page numbers are not present or formatting does not follow assignment instructions	**/2**
• **Section Headings** • **Table of Contents**	• Section headings specified in assignment instructions generated using Word Styles • Table of Contents generated automatically • Document structure follows assignment instructions	• Section headings and Table of Contents are present but have been generated manually • Document structure deviates from assignment instructions in a way that is difficult to follow	• No section headings or Table of Contents • Document structure is disorganized and is difficult to follow	**/2**
• **Figures** • **Tables**	• All Figures and Tables have thorough and well-written captions, generated using Word Captions • Automatic List of Figures & Tables • Figures are appropriately sized & legible • Figures and Tables are linked to Excel	• All Figures and Tables have descriptive, manually generated captions • Manual list of Figures & Tables • Most figures are appropriately sized & clear • Figures and Tables are linked to Excel	• Some Figures and Tables are missing captions or have unclear captions • List of Figures & Tables is incomplete or missing • Figures are illegible, unclear or inappropriately sized • Figures and Tables are screenshot from Excel	**/2**

• **Cross-referencing**	• All Tables & Figures are cross-referenced in text using Word Captions	• All Figures & Tables are cross-referenced in text manually	• Some Figures & Tables are not referenced in text	**/2**
• **Sample Calculation** • **Equations**	• Thorough and descriptive sample calculations are included, following recommended format • All equations are numbered and manually referred to in text • Equations are generated using equation editor in Word Symbols	• Sample calculations are presented but do not follow recommended format • Equations are numbered and manually referred to in text • Equations are not generated using the equation editor in Word Symbols	• Sample calculations are missing steps or missing completely. • Some equations are missing numbers • Some equations are not referenced in text	**/2**
• **Descriptive text at the beginning and end** • **Critical Evaluation of Results**	• Appropriate descriptive text has been included to introduce the results, explain and summarize the results. • The text is clear, concise and thorough • The required conclusions are all present and well-argued	• Marginal descriptive text has been included to introduce the scenario and summarize the results • Text is not concise, partially incomplete or somewhat unclear • Required conclusions are mostly present or argued with some flaws	• Minimal descriptive text has been included to introduce the scenario or summarize the results • The text is largely incomplete or unclear • The required conclusions are missing or poorly argued	**/2**
• **General Formatting**	• All of the following has been used: - Size 11 Calibri font - 3rd person point of view - Left justification - Spaces separate paragraphs (not indented)	• Most of the following has been used: - Size 11 Calibri font - 3rd person point of view - Left justification - Spaces separate paragraphs (not indented)	• None or little of the following has been used: - Size 11 Calibri font - 3rd person point of view - Left justification - Spaces separate paragraphs (not indented)	**/2**

TOTAL	**/16**

8.5 Marking Rubric – Excel

Please note that all of the assignment questions must be completed. An incomplete assignment will receive a zero.

	2	1	0	Mark
	• ***complete with no errors*** • ***consistent, professional formatting***	• ***complete with some errors*** • ***inconsistent formatting***	• ***incomplete or largely incorrect*** • ***improper formatting***	
• **Tables (Data Entry & Formulas)**	• Data is accurate • Data is presented with significant figures consistent with questions • Formulas have been used properly	• Data has some errors • Significant figures are consistent in most numbers • Some formulas have been used properly	• Data is largely inaccurate • Significant figures are inconsistent • Formulas used improperly	**/2**
• **Tables (Formatting)**	• Columns are presented with appropriate headers and units • Professional presentation of information such as: - Minimal Colour - Minimal vertical lines between cells - Minimal horizontal lines between cells • White space has been maximized	• Columns are presented with mostly appropriate headers and units • Poor presentation of information such as: - Unnecessary Colour - Many vertical lines between cells - Unnecessary horizontal lines between cells	• Tables are presented with extra unwanted columns or missing columns • Headers are not included or are a misrepresentation of data • Units are missing or incorrect	**/2**
• **Figures (Error Bars)**	• Error bars are made with the correct equation, varying in length	• Error bars are present, but do not reflect the values from the error equation	• Error bars are not present	**/2**

• **Figures (Trendlines)**	• All trendlines are present and correct • Equations of all trendlines are present	• Trendlines are present • Equations are present, but are partially incorrect	• Trendlines are missing • Equations are missing or entirely incorrect	**/2**
• **Figures** **(Regression Analysis)**	• Regression analysis is complete, reporting correct values for slope and intercept with their standard errors	• Regression analysis is complete, but reported values of slope or intercept are partially incorrect	• Regression analysis has not been completed/reported	**/2**
• **Figures (Residual plot)**	• Residual plot has been produced, and is used to discuss accuracy in conclusion	• Residual plot has minor errors in labeling or interpretation in conclusion	• Residual plot is missing, incorrect or misinterpreted	**/2**
• **Figures (Formatting)**	• Figures include all of the following: - Descriptive axis titles with units - Appropriate Scales - Professional Legends (Overlap Plot) - Appropriate Marker and font sizes • Figures avoid all of the following - Excessive use of horizontal & vertical gridlines - Chart Titles - Unnecessary Colour	• Figures include most of the following: - Descriptive axis titles with units - Appropriate Scales - Professional Legends (Overlap Plot) - Appropriate Marker and font sizes • Figures avoid most of the following - Excessive use of horizontal & vertical gridlines - Chart Titles - Unnecessary Colour	• Figures include most of the following: - Descriptive axis titles with units - Appropriate Scales - Professional Legends (Overlap Plot) - Appropriate Marker & font sizes • Figures avoid most of the following - Excessive use of horizontal & vertical gridlines - Chart Titles - Unnecessary Colour	**/2**
TOTAL				**/14**

8.6 Marking Rubric – Questions

Please note that all of the assignment questions must be completed. An incomplete assignment will receive a zero.

	2	1	0	Mark
	• ***complete with no major errors*** • ***All required deliverables included*** • ***Strong technical understanding demonstrated***	• ***complete with some errors*** • ***Minor missing components or inaccuracies*** • ***Partially correct analysis***	• ***incomplete or largely incorrect*** • ***Missing major deliverables*** • ***Incorrect analysis or incomplete work***	
• **Question 2 *Remote Hydroponic Horticulture System***	• Site is properly evaluated on Google Earth, with three relevant physical or environmental features clearly identified and connected to hydroponic system design consideration	• Site evaluation completed with minor missing observations or incomplete annotations	• Site evaluation incomplete or observations are inaccurate/missing	**/2**
• **Question *3 Artificial Organ Monitoring***	• Citation comparison accurately identifies IEEE formatting differences across all three tools • Appropriate corrections are clearly explained • Demonstrates understanding of limitations of automatic citation generation	• Comparison completed but some formatting differences or IEEE errors have been identified, but analysis is partially incomplete or some corrections are inaccurate/missing	• Comparison incomplete or demonstrates weak understanding of IEEE citation formatting	**/2**
	• Folder structure is fully complete, correctly organized, properly named, and	N/A	• Folder structure is incomplete, incorrectly organized,	**/1**

• **Question 4** ***File Organization***	screenshot clearly displays all required folders and student name		improperly named, or screenshot is missing	
TOTAL				**/5**