EXP2-1 – The same or different

Comparing data and ensuring that data is comparable!

The **aim** of this task is to develop tools and skills, in order to:

- Present and report data in the correct way (units, significant figures, error, and others)
- Determine whether different samples have the same characteristics or properties, whether they behave differently, and whether these differences are statistically significant

The **objectives** of this exercise are:

- Check and analyze the data gathered during the Experiment in "Introduction in Engineering"
- Consider the errors of the data and present a short report
- Critically compare and discuss the results of different samples
- Present a statistics analysis report

For this task you will use the data that previous students gathered during Experiment in 'Introduction in Engineering'. In particular, elongation by weight of your unmodified Sylgard 184, and data produced from samples using Sylgard 184 modified with Urefil-3 (a type of additive), both from the Materials and Polymers Programmes. Please note that numbering system for the data in these files does not correspond in any way to the groups that generated it.

The data in the files is the raw data, as it was presented by students. Since the focus of this Experiment is to explore tools to compare data, for the sake of time, the Young's moduli of the samples have already been calculated for you. **However, it is your responsibility to check that these data or calculations are correct.** In addition, not all the data may have been collected or presented in the correct format. Therefore, it is also your responsibility to check if there are issues with the data, and decide whether to use. Please let your teachers know if there are any data that needs adjusting or removing from the data set, and be prepared to justify your decision.

The following concepts will be relevant for this task:

- mean
- median
- mode
- normal distribution
- standard deviation
- standard error
- regression
- coefficient of determination (R^2)
- t-test
- z-test
- significant figures
- statistically significant
- frequency
- histogram
- binning and bins (in the context of histograms, not in the context of rubbish!)

The **learning outcomes** for this task are to understand, and be able to work with the concepts above. In particular how to calculate the relevant statistics shown above using Excel, and how to compare different samples using different statistical methods. Professional skills associated with this task are time and group management, independent study and research, and report writing.

What you should do:

Part 1 Represent the data in a correct way

Group management meeting 1 (pre-session tasks):

Working with your groups:

1. Look at the instructions for the Experiment in Introduction in Engineering Materials (uploaded on the QMPlus page for this module), recall the procedure of the experiment and identify what major sources of error may appear in the experiment. Make a note of these to discuss in class.

2. Look at data. There are three files provided (Excel Spreadsheets), these are selected data for:
    *   unmodified samples from the Materials Programme
    *   unmodified samples from the Polymer Programme
    *   Urefil-3-modified samples from both Materials and Polymer programmes.

    Write down comments about the quality of the data presented, if relevant. The data presented were taken as they were provided by student groups to teachers, without further modification. There is likely to be data that may present issues for analysis, as not all groups were equally careful about how they gathered, recorded and presented the data. Discuss possible choices about what to do with such data, if anything, and be prepared to justify your choices.

    Important items to discuss: search for outliers, search for ways the data was presented that is incorrect and may affect the results. But always remember, **data is data, and errors are not mistakes**.

3. Carefully read the instructions for the GMM2 & GMM3 tasks below. Then, prepare a **new Excel spreadsheet** (you can find the **template** in 'Raw data files' folder) with available Young's Modulus data (round with **significant figures**) that you will need to analyse for this exercise. This Excel spreadsheet will be submitted together with your report at the end of the task as supplementary, including new sets of data, all calculations processes (functions should be kept) and graphs that you have carried out. You also need to include the essential graphs in the main context of your report.

Group management meeting 2 (please be prepared, you may initiate work ahead of the day):

Working in your groups, consider the following discussion/questions, for which you will need to make calculations using Excel spreadsheets and start writing a report.

Section 1: A discussion of the raw data as presented (see GMM1 tasks), including identification of data that presented serious **issues/mistakes** (not errors), and what was your decision about it, including a short justification.

(No matter if you decide to delete, change or keep the data, you need to show your justification/evidence.)

Section 2: What parameter(s) provide you confidence in the calculated modulus from the measurement (strain-stress)? It would be better if include examples as comparison.

Section 3: What's the **error** in the calculated modulus? Please round all the available Young's modulus with significant figures and calculate the mean, mode, median, SD, SE and CI for all the samples separately, and express the results with **significant figures**. What are the units of the calculation in the raw data files? What units would be the best to use and why?

Section 4: How are you going to describe the samples (Materials and Polymers): do these samples follow a normal distribution? Can you investigate this in a graphic manner? *Note: Do not focus on doing further research, it is nice of you doing this but has to be beyond your critical analysis based on what we have taught in class.*

Part 2 Significance tests

Group management meeting 3 (please be prepared, you may initiate work ahead of the day):

Working in your groups, consider the following discussion/questions, for which you will need to make calculations using Excel spreadsheets and complete writing the report:

Section 5: Are the data from the unmodified Materials and Polymer samples comparable?

Section 6: Are the data from the Urefil-3-modified Materials and Polymer samples comparable?

Section 7: Are the data between unmodified and modified samples comparable?

For the 3 sections above: If they are comparable, at least two methods should be employed, one of which should be by the means of graphics; if they are not comparable, please analyse and explain why, and you are not expected to use other more complex statistics analysis tools/methods out of the session at this stage.

Section 8: A brief discussion of how you dealt with problem solving and group management (corelate with PES). Note: Do not just simply describe what you have done, try to include more meaningful reflections.

Group management meeting 4 (post-session tasks):

Finish the report containing a selection of essential graphs that support your discussion in GMM3, further graphs can be appended on the Excel spreadsheet. (*Your report must be a complete report even without Excel spreadsheet as supplementary) You will submit this report, together with only **1 Excel file** that contains all your relevant calculations and graphs. (Do <u>not</u> re-submit the original Excel spreadsheets that you have been provided on QMPlus, in total, or partially, just an Excel spreadsheet that shows your work in this task).

The report will be **no more than 1500 words** (exclude references) containing **8 sections**. You can give subtitles of each section as you wish, but make sure the structure of your report follows a reasonable logic order. <u>You may use narrow page margins, letters no smaller than font size 11 and line spacing no less than 1.15.</u>

The **title** of the report will be: **EXP2-1 Same or different Report XX** (where XX is your group number, e.g. M16 or P8). The names of **all the group members** should be given as authors of the report *(the group member who doesn't appear as author might be considered as poor contribution with further investigation).*

You will **submit** your group's report as a **pdf document on QMPlus** using the file name:

 'QXU5017 EXP2-1 Report XX' (where XX is your group number, e.g. M9 or P17).

You will **submit** your new Excel file together with your report **on QMPlus** using the file name:
'QXU5017 EXP2-1 Data XX' (where XX is your group number, e.g. M9 or P17).

The report must be completed and **submitted by 24:00 on Monday 11th March 2024**.

The report must be the **work of the whole group** and the content agreed by all group members.

Only one group member needs to hit the submit button to submit the report.

Marks breakdown:

EXP2-1 is 20% of the marks for QXU5017

Schedule:

M Groups

Date:	Time:	Place:	Activity:
Monday 26th	14:00-15:40	A310	Introduction to QXU5017 & EXP2-1 Part1
Wednesday 28th	16:00-17:40	B1-202	Group Meeting 1 (Review and check the raw data)
Thursday 29th	16:00-17:40	B1-202	Group Meeting 2 (Write Report Section 1-4)
Monday 4th	14:00-15:40	A310	Introduction to EXP2-1 Part2
Wednesday 6th	16:00-17:40	B1-202	Group Meeting 3 (Different sample comparison)
Thursday 7th	16:00-17:40	B1-202	Group Meeting 4 (Complete report Section 5-8)
Monday 11th	14:00-15:40	A310	Report submission

P Groups

Date:	Time:	Place:	Activity:
Monday 26th	16:00-17:40	A310	Introduction to QXU5017 & EXP2-1 Part1
Wednesday 28th	14:00-15:40	B1-302	Group Meeting 1 (Review and check the raw data)
Thursday 29th	14:00-15:40	B1-302	Group Meeting 2 (Write Report Section 1-4)
Monday 4th	16:00-17:40	A310	Introduction to EXP2-1 Part2
Wednesday 6th	14:00-15:40	B1-302	Group Meeting 3 (Different sample comparison)
Thursday 7th	14:00-15:40	B1-302	Group Meeting 4 (Complete report Section 5-8)
Monday 11th	16:00-17:40	A310	Report submission