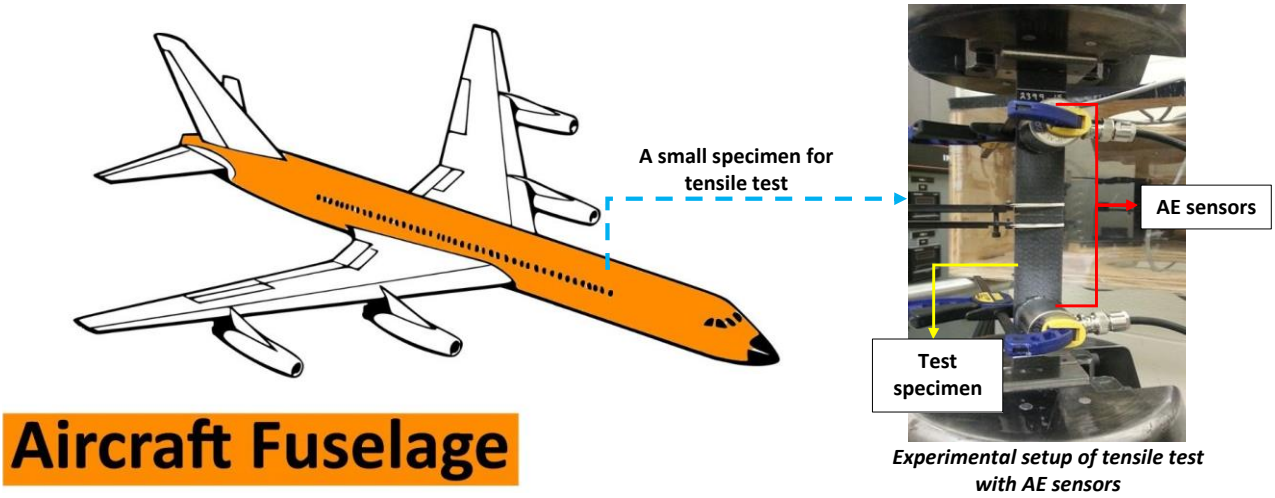
BACKGROUND

An aircraft company wants to evaluate the strength of a potential Carbon Fiber Reinforced Polymer (CFRP) composite material for manufactuing fuselage of their new model. For this purpose, they want to test the performance of this material under tensile tensile loading. However, a sole tensile test is not sufficient for the aviation requirements. Because a tensile test can only provide limited properties, such as, elastic modulus and tensile strength. The company needs the information of damage initiation tensile stress level. A non-destructive technique, called Acoustic Emission (AE), is a useful methodology to determine it. In this methodology, two piezoelectric sensors are placed on test specimens and they collect signal as the specimen is loaded. If, no signal is registered, then it means that no cracking occurs. The first signal provides information for the time and tensile stress levels of damage initiation.



Experimental setup of tensile test with AE sensors

Tensile stress and ***tensile extension*** applied to the specimen are recorded. On the other hand, registered AE signals are data that can be used for identification of sound characteristics of the damage. Raw AE data consist of seven different parameters as shown below:

- Registration ***Time*** of a signal
- Corresponding test ***Extension*** level of the signal.
  (Extension column can be used to make a correlation with tensile extension and tensile stress data)
- ***Rise Time*** of a signal
- ***Duration*** of a signal
- ***Amplitude*** of a signal
- ***Frequency centroid***
- ***Peak frequency***

Aforementioned data are listed in the attached excel file. There are two sheets in this file. First sheet lists the tensile extension and tensile stress on the specimen. Second sheet includes the AE data and their registration time and extension levels.

YOUR TASKS

1. Test technician forgot to list the number of signals. You have to write its number for each signal, starting from 1 until the last number. List the values in the "NUMBER OF SIGNAL" column.
2. Also, the summation of signal energy was forgotten. Engineers need to see the cumulation of signal energy throughout the test. Because of this, you must sum the signal energy of each step as follow:

$$Total\ signal\ energy\ of\ \text{a}\ step = (Signal\ energy\ of\ this\ step) + (Total\ signal\ energy\ until\ the\ previous\ step)$$

3. Weighted frequency value of each signal was not calculated. You have to calculate this value according the given formula and list it for each signal in the "WEIGHTED FREQUENCY" column.

$$Weighted\ Frequency = \sqrt{(Peak\ Frequency) \cdot (Frequency\ Centroid)}$$

4. It is seen that there are noise or redundant signals were recorded and listed in this excel file. These signals can cause misinterpretation for determination of damage initiation.
   You should write such a conditional formula that should write all the parameters in different columns if that signal's amplitude is greater than 60 dB. If not, then -1 should be written in regarding row.
5. Clear out the redundant signals ("-1" rows).
6. Plot two graphs:
   a. First graph should present "tensile stress vs. test extension" (scatter plot with smooth lines) and "amplitude vs. extension" (scatter plot)
      i. In this plot, show AE clusters with different markers and colours:
         65 < Amplitude < 75 : Red squares
         75 ≤ Amplitude < 85 : Blue triangles
         85 ≤ Amplitude < 95 : Green diamonds
         (Hint: First you must list these groups in different columns, then add them as different series)
   b. Second graph should present "tensile stress vs. test extension" with "peak frequency vs. extension"
      i. In this plot, show AE clusters with different markers and colours:
         0 < Peak Frequency < 250 : Red squares
         250 ≤ Peak Frequency < 400 : Blue triangles
         400 ≤ Peak Frequency < 600 : Green diamonds
         600 ≤ Peak Frequency : Pink circles
         (Hint: First you must list these groups in different columns, then add them as different series)

7. Another plot is required to calculate the elastic modulus of the the material.
    a. Elastic modulus is calculated as follow:

$$Elastic\ Modulus\ (MPa) = \frac{Tensile\ stress\ between\ 0.1\% - 0.3\%\ tensile\ extension}{0.1\% - 0.3\%\ tensile\ extension} \cdot \frac{1}{100}$$

    (Hint: You can do it by plotting "tensile stress vs. tensile extension" between the aforementioned values, add a linear trendline to curve and show the equation of that trendline on graph as y=ax+b. Then if you multiply "a" with (1/100), here is the elastic modulus)
8. Find the tensile strength of the material. Tensile strength is the maximum tensile stress.
    (Find the maximum stress by using a formula in report page)
9. Find the tensile stress level of damage initiation.
    (First AE signal is due to damage initiation. You can make a correlation between its extension level and tensile extension and use a "look up" type formula to find the tensile stress value)
10. Summarize your results in the report page.
    a. Fill the required cells, by using the correct formulas.
    b. Paste your graphs in the required boxes, adjust the dimensions of the graphs according to the given boxes
    c. Set your report as the print area in one page and center it on the page.

DO NOT FORGET TO ADD LEGENDS, AXIS TITLES TO GRAPHS.

READERS SHOULD KNOW WHAT EACH SERIES REPRESENT.

After you complete your homework:

- Save your Excel file with your Group number, i.e. ***Group1.xlsx***
- Click this link and upload your excel file: https://www.dropbox.com/request/m5YSdrUCbJNGfyiuItCE
- **Deadline: 29.10.2019 – 23:00**. Link will be deactivated after this time.