Coursework Assignment Overview

Aim: In the coursework assignment a detailed analysis of the data collected in the laboratory classes will be carried out. The mechanical properties of the aluminium alloy material that was tested will be derived from the different experimental mechanics procedures. The stresses and strains in the disc will be derived using each technique and the values from each technique compared. The virtual fields method will be used extract the material properties from the data from the discs obtained using the white light techniques.

Detailed descriptions of each experiment are given in the 'Laboratory Classes Handout'.

The findings from the experimental work undertaken during the module should be written-up into a formal technical report of no longer than 3000 words (not including tables and figures) and not exceeding 25 pages. Descriptions of the experiments should be given along with clear discussion. Marks will be allocated for presentation as well as for technical content. All graphs need gridlines, legend, axes need to be labelled and units must be provided.

The report constitutes the coursework for the module and is worth 100% of the module marks. The deadline for submission is **Friday 11th May 2018**. The Coursework Assignment Report is to be up loaded into on the blackboard site as a single .pdf and the file name should be firstname_lastname_EM.

There are six coursework activities in the assignment. The table below gives the coursework activity and its overall percentage for the module.

Coursework title	**Weighting**
Brazilian disc analysis	10%
Dog bone tensile test	15%
Camera set up	15%
DIC, Grid and VFM on Brazilian disc	25%
TSA	15%
Comparison of derived stresses	10%
Conclusions	10%

In the following sections below the format of the Coursework Assignment Report and details of what must be included are provided.

Section 1 'Introduction'

A brief overview of the contents of the report – no more than 200 words are required.

Section 2 'Brazilian disc analysis **'**

This is essentially the pre-assignment. You should:

1. Produce the plots of the stresses and strains in the disc using the code you have produced.

2. Upload the executable file you have used to produce the plots and describe briefly in the report how you set up your code (you can include a print out of the code in an appendix).
3. Answers the five questions given in the pre-assignment.

Section 3 'Dog bone tensile test**'**

Provide a description of each experiment, the loads used and how the strain measurements were obtained (200 words maximum).

3.1 Strain gauge and extensometer data

During the test the load, displacement and strain (from the extensometer and the strain gauge) was recorded for each test. This data is available in the shared folder. The data from the test machine is an excel spreadsheet with four columns time, displacement, strain and load; it is obvious which is which. The strain gauge data is saved in a separate tab in the excel spreadsheet with columns of data: time, three values of strain, load and stress. Grid 3 is the longitudinal strain, Grids 1 and 2 are the values of strain taken from the other two gauges in the rosette. Grid 1 is the transverse strain from this and the longitudinal strain Poisson's ratio can be calculated. From this data:

1. Convert the load data to stress data using the cross sectional area of the specimen.
2. Obtain the stress strain curve for each test (both for the extensometer and the strain gauges) and plot on the same axes.
3. From the fit of the straight line through the data evaluate Young's Modulus.
4. Plot the transverse strain against the longitudinal strain from the strain gauges and obtain Poisson's ratio.

3.2 DIC data

Now by using the data collected from DIC:

1. Plot the stress-strain curve to failure.
2. Obtain the yield strength of the material and the ultimate strength, as well as the Young's modulus and Poisson's ratio.
3. Make a table comparing the Young's modulus values from the extensometer, strain gauge and DIC.

Section 4 'Camera set up'

Provide a brief description of the experiment. Two sets of two images are provided in your assignment material, corresponding to two different lighting conditions.

1. Evaluate grey level camera noise for both sets of images. To do so, you will have to upload the images in Matlab to perform image subtraction. To enable positive and negative values for the subtracted map, ensure you have converted your images into Matlab 'double' format (otherwise, the map will be of 'integer' nature and the differences will always be positive values). Compare the noise levels for the two sets of lighting conditions.

2. Using the digital image correlation software, evaluate the displacement resolution for both sets of lighting conditions. Plot a graph representing these values as a function of DIC subset size.
3. Repeat the same with strain.
4. Complete the measurement information table provided in the data processing lecture for what you think are suitable conditions from the above analysis. Justify you choice.

Section 5 'DIC, Grid and VFM on Brazilian disc'

Provide a brief description of the experiment. Note the Grid specimen has the same dimensions as the DIC specimen, except instead of a speckle pattern a grid was applied. The loading for the Grid specimen is identical to that used in the for DIC specimen. This section of the report should include:

1. Process the DIC data for the disc into strains (for load steps 0.5 to 5 kN and 0.5 to 9.5 kN) – use three different interrogation cell sizes and step sizes (along the lines of 31, 15 and 61, 31) using the DaVis software. Comment on the quality of the data from this.
2. Process the Grid data for the disc into strains (for load steps 0.5 to 5 kN and 0.5 to 9.5 kN) –using the GUI provided.
3. For both Grid and DIC compare the extracted strains from along the vertical diameter of the disc with the theoretical solution. Compare the values from the Grid method with the value from the DIC.
4. Compare the values from the strain gauges with the value from the DIC at the centre of the disc (average across different areas to obtain the strain values at the centre).
5. Use the virtual fields method to obtain Young's modulus and Poisson's ratio from both the Grid and the DIC. Compare with the values from the tensile test and discuss the differences.

Section 6 'Thermoelastic stress analysis (TSA)'

Provide a brief description the two experiments: the dogbone loaded in tension to obtain the thermoelastic constant and the disc experiment. Use the GUI to process the TSA data and:

1. Derive the thermoelastic constant of the material and compare the value with a value derived from literature values.
2. Use the experimental value of the thermoelastic constant to convert the TSA data for the disc into stress units (MPa) and present the plot in the assignment.
3. Plot the extracted stress sum values along the vertical diameter of the disc for both loads with the theoretical solution.
4. Derive the stress sum values from the Grid method and the DIC plot along the vertical diameter of the disc and compare with the TSA.

Section 7 'Comparison of derived stresses**'**

1. Use the tensile test values of Young's modulus and Poisson's ratio to convert the strains obtained from the DIC and Grid into stresses.

2. Provide a plot of the stresses along the vertical diameter of the disc for both the DIC and the Grid method and compare with theory.
3. Derive the stress sum values from the Grid method and the DIC plot along the vertical diameter of the disc and compare with the TSA and theory.

Section 8 'Conclusions'
The report must finish with at least 10 strong conclusions comparing each technique accompanied by discussion on the accuracy, precision and applicability of each of the experimental techniques.