University of Central Lancashire UCLan School of Engineering	**UCLan Coursework Assessment Brief**	Academic Year **2022-2023**
	Module Title: **Structures and FEA** Module Code: **EI2910**	Level **5**
	FEA Course work Brief	This assessment is worth 50% of the overall module mark

THE BRIEF/INSTRUCTIONS

- **The course work aims to evaluate the structural understanding and design optimisation of aeroplane component using Finite Element Analysis (FEA). Students should analyse the proposed task by utilizing appropriate CAE frameworks and submit a report of their results as a single PDF file.**
- **Course work 1 has been divided into two section,**
  Part A is the Individual practical report worth 25% of the total marks.
  Part B is the FEA using Ansys report worth 75% of the total marks.
- **Maximum word count shouldn't exceed 500, 1500 Words for Part A and Part B respectively. The whole report shouldn't exceed 2000 words.**
- **Details of the Course work brief is provided with the Course work Task (Part B). Similarly, submission requirements have been provided in Guide for report.**
- **Marking criteria for assessment and weightings is provided in the Appendix A.**
- **Module Learning Outcomes accessed in this Course work (LO-1,2,5)**
  1. **Understand the criteria used for selecting aircraft materials and the stress analysis of aircraft structures.**
  2. **Discuss how structural loading and stress analysis influence the decisions upon large commercial aircraft shape and airworthiness.**
  3. **Demonstrate effective research and report writing skills**

PREPARATION FOR THE ASSESSMENT

- The lectures and Ansys tutorial will provide you a guidance to undertake the Course work. Relevant course work materials could be found in the Module Materials folder for the course in Blackboard.
- Reading list is in the Blackboard for this course.

RELEASE DATES AND HAND IN DEADLINE

Assessment Release date: [14/10/2022] Assessment Deadline Date and time: [14/12/2022]

Please note that this is the final time you can submit – not the time to submit!
Your feedback/feed forward and mark for this assessment will be provided on [17/01/2023]

SUBMISSION DETAILS

The coursework should be your own work and should use appropriate referencing style. Your assignment must be submitted electronically via blackboard by the submission time or before. Submit a report as a single PDF file.

HELP AND SUPPORT

- Academic support for this assessment will be discussed in the lectures and Ansys tutorial sessions. Please contact Dr. Kirijen Vengadasalam (Module Leader) if you have any further queries. E-mail: kvengadasalam@uclan.ac.uk
- For support with using library resources, Neil Marshall, NMarshall7@uclan.ac.uk or SubjectLibrarians@uclan.ac.uk. You will find links to lots of useful resources in the My Library tab on Blackboard.
- If you have not yet made the university aware of any disability, specific learning difficulty, long-term health or mental health condition, please complete a Disclosure Form. The Inclusive Support team will then contact to discuss reasonable adjustments and support relating to any disability. For more information, visit the Inclusive Support site.
- To access mental health and wellbeing support, please complete our online referral form. Alternatively, you can email wellbeing@uclan.ac.uk, call 01772 893020 or visit our UCLan Wellbeing Service pages for more information.
- If you have any other query or require further support you can contact The Student Information and Support Centre. Speak with us for advice on accessing all the University services as well as the Library services. Whatever your query, our expert staff will be able to help and support you. For more information , how to contact us and our opening hours visit Student Information and Support Centre.

If you have any valid mitigating circumstances that mean you cannot meet an assessment submission deadline and you wish to request an extension, you will need to apply online prior to the deadline.

Disclaimer: The information provided in this assessment brief is correct at time of publication. In the unlikely event that any changes are deemed necessary, they will be communicated clearly via e-mail and a new version of this assessment brief will be circulated.	Version: 1

Course work 1

Coursework Tasks

Part A

You are required to attend the practical session to obtain the results from the laboratory session.

1. The tutor will introduce the activities of the laboratory session using the laboratory manual.
2. Report your activities and findings as part of your Assignment.
   - guide, this could be around 2 to 3 pages or **Maximum word count shouldn't exceed 500 Words**.
   - You may want to include the following (sections) in your report:
     - Introduction (3 marks)
     - Methodology (5 marks)
     - Results and Discussion (12 marks)
     - Conclusion (5 marks)

Part B

In terms of wing motion, unmanned air vehicles can be divided into three categories. Fixed-wing, rotary-wing and flapping-wing aircraft are the three types. Each of the three types has advantages and disadvantages in comparison to the others. Although fixed-wing airplanes have a disadvantage in terms of take-off and landing distances, rotary-wing and flapping-wing airplanes have issues with payload ability and long-range flight as compared to fixed-wing airplanes. Combining the benefits of all three types of UAVs to reveal a more effective UAV design is generally the main goal. As aviation technology advances, the obstacles that must be overcome become more complex. In recent years, researchers around the world have begun to investigate the development of a reliable controller for VTOL systems in the transition phase of flight. The exploration of the structural behavior of the VTOL component will provide an understanding of the different failure modes. Figure 1 shows the VTOL CAD model.

Figure 1:VTOL model

Problem specification

This assignment focuses on best material that is suitable for the VTOL UAV. For wing Skelton structure use S1223 profile. VTOL UAV wing specification are shown in Table 1. Then apply the boundary conditions on the VTOL UAV wing according to the tasks specified below.

Table 1: VTOL UAV wing specification

VTOL UAV model	
Wing area (m^2) (Assumption)	0.575
Wing span (m) (Assumption)	2
MAC (m)	0.33
Aspect ratio	6.95
Taper ratio	0.7
Root Chord	0.36
Aero foil Type	S1223
Sweep Angle	5˚
Lift Coefficient	1.2806
Air Density (kg/m^3)	1.225

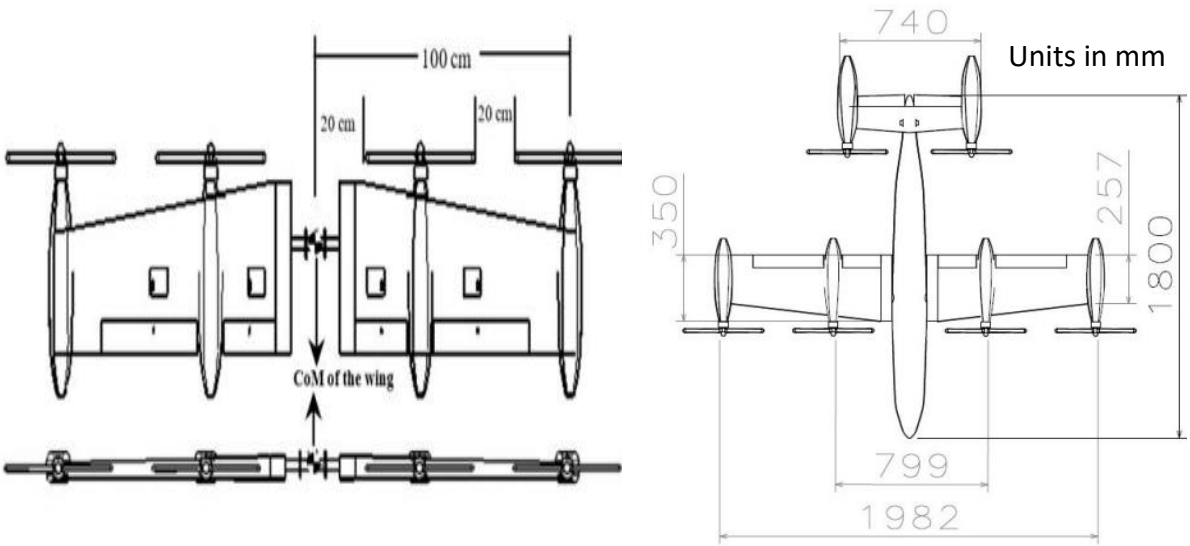

Figure 2: VTOL UAV dimensions

The following outlines the tasks that are required to address in the final report.

Create a profile of a NACA aerofoil using the link provided (http://airfoiltools.com).

a) Examine the point load ranging from 500 N to 5000 N with an increment of 500 N, at end of the wing. The wing is made of Aluminium alloys (AA2024). Justify your answers.

b) Compare the point load solution with a theoretical solution for all the cases examined in Part (a).

c) Inspect the effects of different materials such as Aluminium alloy, Titanium alloy, Steel and Carbon fibre for a velocity range of 40 m/s to 90 m/s with an increment of 10 m/s. Justify your answers.

d) Examine the end of wing twisting effect (moments) of 500 Nm to 5000 Nm with an increment of 500 Nm. The wing is made of Aluminium alloys (AA2024). Also model the wing as a surface and solid shape. Justify your answers.

e) Optimise the design (maximum 5 different designs) of a VTOL wing to have a stress below the Aluminium alloy elasticity region. The top surface of wing will have distributed load of 1000 N/m. Explain the reasoning behind the final design concepts. (Hint: think in terms of sustainability)

References

1. Muraoka, K., Okada, N. and Kubo, D., 2009, April. Quad tilt wing vtol uav: Aerodynamic characteristics and prototype flight. In AIAA Infotech@ Aerospace Conference and AIAA Unmanned... Unlimited Conference (p. 1834).
2. Misra, A., Jayachandran, S., Kenche, S., Katoch, A., Suresh, A., Gundabattini, E., Selvaraj, S.K. and Legesse, A.A., 2022. A Review on Vertical Take-Off and Landing (VTOL) Tilt-Rotor and Tilt Wing Unmanned Aerial Vehicles (UAVs). *Journal of Engineering*, *2022*.

Guide for Part B REPORT

Section 1. Introduction [Guideline length: ~100 - 200 words] (3 marks)

Provide a brief description of the task using the following questions to guide your discussion. Do not limit yourself to these questions.

- Why is FEA useful for examining aircraft structures?

Section 2. Method [Guideline length: ~300 - 400 words] (15 marks)

- Outline the suitability of the methods employed in this study, *i.e.* geometry creation, material choice, boundary conditions (such as fixed points, environmental conditions, loading points, any restrictions to the model) and solution protocols, *etc.*
- Assumption to the model.
- Address the theoretical equations for point load

Section 3. Results [Guideline length: ~400 - 600 words] (39 marks)

Include the analysis and plots along with a brief summary of the main features of the results of each part of the task.

- Force vs displacement graph
- Stress vs strain graph
- Structural parameters like total deformation, equivalent stress, maximum principle stress, equivalent strain and shear stress.

Section 4. Discussion and conclusions [Guideline length: ~700 - 800 words] (15 marks)

Critically analyse your results, drawing conclusions on each part of the task. You should not introduce new results at this stage. You should include the following discussion points:

- Provide a detailed description of each results by explaining the salient features of the results.
- The differences in displacement/strain/stress fields of the aerofoil conditions.
- Any (un)realistic implications of the results found and the error source should be clearly explained in the discussion.

Section 5. References (3 marks)

Make sure all data and information are clearly cited in the text and the references are in a correct IEEE format.

Some additional comments to bear in mind:

- Submit a single PDF file via Turn-it-in assignment in Blackboard on or before the due date.
- Marks will be awarded for originality, relevance and logic of arguments, and clearly defined conclusions.
- Make sure all figures and tables are labelled and correctly cited in the text as required.
- Do not include figures or tables that you do not refer to in the text.
- Your conclusions should be drawn from the presented information and any appropriate external sources (which must be appropriately cited).
- You can include additional information in appendices which may be referred to in the main body of the report (Appendixes will not be counted in the page limit).

Appendix A: Marking Rubric

Table 2. Marking rubric for report.

Section/ Grade ranges	Under 40%	40-49%	50-59%	60-69%	Above 70%
Introduction, background theory and general formatting	Introduction and background theory not well defined. Not enough information to understand the report.	Introduction and background theory adequately defined. Adequate formatting of report but lacking clarity.	Clearly defined introduction and background theory. Clear formatting of report, however lacking insight and connection.	Clear concise description of introduction and background theory. Coherent and comprehensive report with good formatting.	Excellent description of introduction and background theory. Original and flowing with excellent formatting.
Methodology	Methodology not well defined. Not enough information to repeat the simulation. Assumptions and theoretical validation equation are not mentioned	Methodology adequately defined. Adequate formatting of report but lacking clarity. Assumptions and theoretical validation equation are sufficiently mentioned	Clearly defined Methodology. Clear formatting of report, however lacking insight and connection. Assumptions and theoretical validation equation are evidently mentioned	Clear concise description of Methodology. Coherent and comprehensive report with good formatting. Assumptions and theoretical validation equation are clearly mentioned	Excellent description of Methodology. Original and flowing with excellent formatting. Assumptions and theoretical validation equation are mentioned precisely
Data processing and results	Major errors in data processing leading to incorrect results, poor presentation.	Minor errors in data processing, poorly presented results with unclear description of general trends.	Data processing completed proficiently. Results clearly described and presented with some minor cosmetic faults.	Results described and presented in a clear and appropriate manner. Results clearly relevant to the context of report.	Clear presentation and comprehensive description of results showing originality.
Discussions and conclusions	No clearly supported conclusions. No critical assessment of results undertaken.	Conclusions defined with limited links to supporting material. Discussion lacking clarity and insight. Limited reference to results and no relation to background theory.	Well defined conclusions with supporting evidence. Discussion is pedestrian and lacking insight, with no relation to background theory.	Well defined conclusions with good supporting evidence. Good discussion linking background theory and results.	Excellently defined conclusions with clearly defined appropriate supporting evidence. Excellent discussion linking all sections of the report in a concise manner. Excellent critical analysis of the results.
Use of references	No clear use of references.	Adequate use references with appropriate formatting.	Appropriate use of references with correct formatting.	Good use of reference material with correct formatting.	Excellent use of reference material with correct formatting.