Loughborough University

Computer Aided Engineering

23WSC301

Semester 2 In-Person Exam paper

This examination is to take place in-person at a central University venue under exam conditions. The standard length of time for this paper is **2 hours**.

You will not be able to leave the exam hall for the first 30 or final 15 minutes of your exam. Your invigilator will collect your exam paper when you have finished.

Help during the exam

Invigilators are not able to answer queries about the content of your exam paper. Instead, please make a note of your query in your answer script to be considered during the marking process.

If you feel unwell, please raise your hand so that an invigilator can assist you.

Answer **ALL THREE** questions.

All questions carry equal marks.

Use a **SEPARATE** answer book for **EACH** question.

Calculators are **NOT** permitted.

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1. Virtual Reality (VR) is now seen as a mainstream engineering tool within the engineering design process.

a) Identify three main types of virtual reality systems, contrasting utilisation, hardware requirements, implementation and effectiveness. [9 marks]

b) Give practical examples of virtual reality usage in each of:

i. Industrial Design [3 marks]

ii. Maintenance Engineering [3 marks]

c) What human computer interface problems may be experienced with VR systems? [4 marks]

d) How might solid models and assemblies be transferred to a VR system and what are the shortcomings of this transfer process? [4 marks]

e) What is the next logical extension in product realisation using a CAE system? [2 marks]

2.

a) Assembly Constraints can be used to ensure component parts maintain their intended positions within an assembly.

i. Using before and after illustrations, give a simple example of an ALIGN assembly constraint definition, showing linked geometry and surface normal directions. [2 marks]

ii. How do Assembly Constraints differ from positional (Cartesian) coordinates and why is this important? [3 marks]

iii. Discuss why Assembly Constraints are important when constructing a virtual mechanism (Motion Simulation). [2 marks]

b) Photo quality images of a new product are required for a pre-production marketing brochure. State how this can be achieved economically using a modern CAE system and what you would need to define. [7 marks]

c) What is the Master Model Concept (MMC)? How does the MMC condense the Product Development Cycle, when compared to a more traditional approach? [4 marks]

d) What is the concept of Model Based Definition(MBD)? Identify the main elements of Product & Manufacturing Information typically communicated. [3 marks]

If MBD is successfully implemented, briefly discuss the following:

i. The impact on engineering drawings; [1 mark]

ii. How (i) impacts version control errors; [1 mark]

iii. Key savings and investments needed. [2 marks]

3. You are asked to assess the viability of a new domestic wind energy generator blade. The original blade geometry provided to you is shown in **Figure Q.3**.

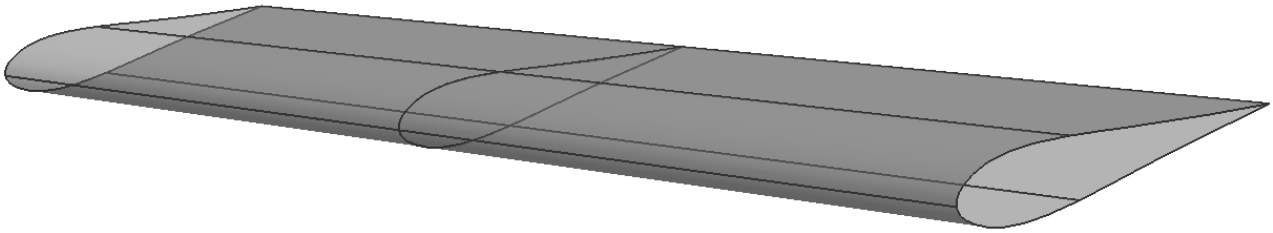

Figure Q.3 – The original blade geometry

a) Is the original blade geometry suitable for mesh generation? If not, state what changes you would introduce and why they are needed. [4 marks]

b) You need to check for stresses due to maximum aerodynamic loading occurring during a possible resonant condition.

i. Assuming that the unsteady aerodynamic loading is known, describe how would you build a finite element model starting from the geometry. [5 marks]

ii. Which of the following forms of equations would be most suitable for this problem, justify your answer: [3 marks]

1. $[M]\{\ddot{u}\}+[B]\{\dot{u}\}+[K]\{u\}=\{f\}$, or

2. $[K]\{u\}=\{f\}$

c) You will need to build a Computational Fluid Dynamics (CFD) model in order to obtain aerodynamic loading. Suggest which conservation equations need solving to obtain the loadings, justify your answer. [5 marks]

d) What type of solver(s) would be the most appropriate for this application, (i.e. low speed flow), Explicit; Semi-implicit; or Implicit? [3 marks]

e) For your CFD computation you have a choice of using either standard Cartesian meshes with immersed boundaries, or a tetrahedral mesh. Which mesh generator would you choose for this application and why? [5 marks]

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