Loughborough University

COMPUTER AIDED ENGINEERING

22WSC301

Semester 2 2023 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.

You may use a calculator for this exam. It must comply with the University's Calculator Policy for In-Person exams, in particular that it must not be able to transmit or receive information (e.g. mobile devices and smart watches are **not** allowed).

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(22WSC301)

Semester 2 2023 2 Hours

Answer **ALL THREE** questions.

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

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1. Using appropriate examples, answer the following in the context of a small engineering design consultancy:

a) Within the scope of data exchange between CAE systems and software, what are the objectives of a neutral file format? [5 marks]

b) What is the structure and functionality within an IGES (Initial Graphics Exchange Specification) file? What problems may you encounter with the use of an IGES file? [5 marks]

c) How have the concepts of neutral file formats changed over the past thirty years, and what is anticipated for the future? [5 marks]

d) What is the role of Product Data Management (PDM) in the engineering design environment? [5 marks]

e) What issues are likely to inhibit the successful implementation of PDM systems in industry? [5 marks]

2. An automotive equipment manufacturer requires a stylised design of a plastic engine oil bottle which incorporates a hollow carrying handle. The customer wants the bottles in three precise volumes of 1.0, 2.0 and 5.0 litres, with an identical corporate styling throughout. Use sketches where appropriate to illustrate your answers to the following:

a) Describe the construction method for such a bottle design using curves and surfaces. [5 marks]

b) CAE tools can be used to identify problems early in the product development cycle.

i. Suggest how this model can be inspected for minor flaws. [1 mark]

ii. How can the model be subsequently edited to rectify any flaws? [2 marks]

iii. How can surface inspection help you prepare for manufacture? [3 marks]

c) Outline the steps necessary to get from a SHEET body of arbitrary size, to a female die cavity for one of the desired volumes. [5 marks]

d) A Computer Numerical Controlled (CNC) programme is required for a female mould cavity of one half of the bottle design. Explain with the aid of sketches the essential steps needed to create the CNC programme for a 3-axis milling machine. [9 marks]

3. There is a danger that a fragment of an old space satellite will re-enter the Earth's atmosphere and start heading towards a highly populated area. You know the initial geometry of the fragment which is hexahedral, in addition to its estimated trajectory and supersonic velocities at all altitudes. You are asked to use Computational Fluid Dynamics (CFD) to assess if the fragment is likely to change its shape or partially burn up before it reaches the Earth.

a) You have at your disposal a Cartesian mesh generator with immersed boundaries and a Cartesian mesh generator with conformal mapping. Choose which is the most suitable for this application, justifying your selection. [4 marks]

b) What key information would you expect to find from output of this computation in order to solve this problem? How would you use it? Which conservation equations will you need to solve? [6 marks]

c) Which of the following space discretisation techniques will you choose and why? Finite Element, Finite Volume or Finite Difference. [4 marks]

d) Describe the mesh adaptivity techniques which you are familiar with and state which one is suitable for your chosen discretisation method. Justify your selection. [6 marks]

e) Suggest how you would verify if your computation was correct. [5 marks]

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