Loughborough University

MANUFACTURING PROCESS TECHNOLOGY

22WSB600

Semester 1 2022 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).

Loughborough University

MANUFACTURING PROCESS TECHNOLOGY

(22WSB600)

January 2023 2 Hours

Answer **ALL THREE** questions.

All questions carry equal marks.

Any University-approved calculator is permitted.

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1. Casting is carried out through solidification of liquid metals or alloys. Solidification in casting exerts a fundamental influence on the properties such as metallographic structure and soundness of casting. Solidification of most metals or alloys is accompanied by appreciable volume contraction during casting which can become a primary cause of casting defects.

a) With the aid of diagram explain the forms of shrinkage defects and the causes of their formations. [10 marks]

b) Hot tear is a typical defect induced by alloy contractions in steel casting, explain how hot tear occurs, and your strategies to avoid such defect. [10 marks]

2. Metal forming occurs in the solid state through plastic deformation (permanent deformation) without causing any fractures or failures. Therefore, metal forming needs to consider material ductility, pressure, force, and equipment that may be used to apply the necessary force to enable the plastic deformation. In the forming of low carbon steels, with the aid of diagram explain:

a) How yields-point elongation occurs and formation of Lueder's bands. [10 marks]

b) Your solution to overcome Lueder's bands. [10 marks]

3.

a) Additive Manufacturing can be applied at different stages of product lifecycle management. Name three of such applications and explain one in detail. [5 marks]

b) Laser-based additive manufacturing technology was used to produce a metallic component for aerospace application. The power of the laser was 2 kW, and it had a scan speed of 1 m/min and a powder feed rate of 10 g/min. Calculate the laser energy per unit length, and the powder fed per unit length of the technology. [5 marks]

c) A single acrylonitrile butadiene styrene (ABS) filament spool was fed into a heated extruder of a material extrusion (ME) additive manufacturing technology at a temperature range of 250 – 280 ^{o}C. The ME machine was used to print a component of a prototype medical device. Calculate the rate at which the polymer was extruded to print the component if the nozzle diameter was 0.3 mm, and a layer height of 0.25 mm was printed at the rate of 90 mm/s. [5 marks]

d) Using a suitable diagram, describe how powder bed fusion (PBF) can be used for rapid production based on the 5 stages of additive manufacturing. [5 marks]

C Ogbonnaya
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