NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2022-2023

MA6502 – FUNDAMENTALS & ADVANCES IN ADDITIVE MANUFACTURING

April/May 2023 Time Allowed: 3 hours

INSTRUCTIONS

1. This paper contains **FOUR** (**4**) questions and comprises **THREE** (**3**) pages.
2. **COMPULSORY** to answer **ALL** questions.
3. Marks for each question are as indicated.
4. This is a **CLOSED-BOOK** examination.

---

1. (a) Laminated Object Manufacturing (LOM) process produces 3D parts using rolls of paper as printing material. Explain the 3D printing process of LOM.

(6 marks)

(b) Name TWO (2) strengths and TWO (2) weaknesses of the LOM process as a prototyping technique.

(4 marks)

(c) Compare and explain the following parameters between inkjet printing and aerosol jet printing.

(9 marks)

(i) Ink viscosity
(ii) Droplet size
(iii) Minimum feature size

(d) Name SIX (6) factors that influence the printing speed and resolution of stereolithography apparatus (SLA).

(6 marks)

2. (a) The flowability of powder used in powder-bed fusion (PBF) additive manufacturing techniques plays a key role in influencing the process performance and end part properties. Explain what is flowability and why flowability of powder is important in powder-bed fusion processes.

(6 marks)

(b) Name TWO (2) measurement techniques to measure powder flowability. Provide a figure to aid your explanation.

(10 marks)

(c) ISO and ASTM International have proposed an Additive Manufacturing Standards Development Structure. All standards for additive manufacturing are classified under three levels in this structure. Explain the levels in this structure and the significance of this structure.

(9 marks)

3.

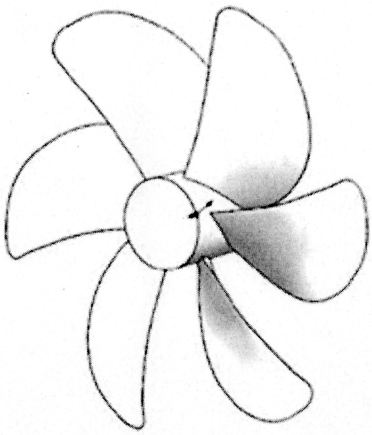

Figure 1 Ship propeller

(a) Figure 1 shows the design of a ship propeller with a diameter of 1300 mm. A company plans to fabricate the structure using 3D printing technique. The company also prefers to use wire feedstock material. You are tasked to recommend a Directed Energy Deposition (DED) 3D printing technique that is suitable to fabricate this large 3D part directly. Explain the process and include a diagram.

(10 marks)

(b) What are the advantages of this technique? Discuss THREE (3) advantages.

(6 marks)

(c) To improve the printing quality of the ship propeller, the company is exploring a new hybrid technique that combines a directed energy deposition and a subtractive process. Discuss TWO (2) advantages and TWO (2) challenges of such hybrid manufacturing approach.

(9 marks)

4. (a) Material extrusion technique such as Fused Deposition Modelling (FDM) is a commonly seen technique in many offices and companies. Discuss TWO (2) challenges of producing multi-colour parts using material extrusion technique. Propose ONE (1) method that could overcome the challenges.

(7 marks)

(b) The production of large metal tool or mould is one of the most common uses for Binder Jetting technique. Explain the fabrication process of ExOne Metal 3D Printing.

(10 marks)

(c) What are the requirements of binders in binder jetting process? Name FOUR (4) requirements.

(8 marks)

END OF PAPER

MA6502 FUNDAMENTALS & ADVANCES IN ADDITIVE MANUFACTURING

Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.