NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

MASTER OF MANUFACTURING ENGINEERING AND OPERATIONS MANAGEMENT

MANUFACTURING TECHNOLOGY EIE 6122

Main Examination Paper Semester II

September/October 2024

This examination paper consists of 4 printed pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Dr Nicholas Tayisepi (Pr. Eng) and Dr Lameck Mugwagwa (Pr. Eng)

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer any four (4) questions. Attempt a maximum of two (2) questions from each section.
2. Each question carries 25 marks.
3. Use of calculators is permissible.

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
5.	25
6.	25
TOTAL MARKS ATTAINABLE BY CANDIDATE	100

SECTION A

QUESTION ONE

(i) One of the most important components in machining processes include the selection of cutting tool materials so that the cutting performance be effectively executed. Explain the reasons predicating the evolution of cutting tools. **[10]**

(ii) Write discussion notes on any five (5) types of cutting tool materials. **[15]**

QUESTION TWO

(a) Describe the consequences of exceeding the allowable wear land for various cutting-tool materials. **[4]**

(b) Explain why machining operations would be necessary even on net-shape or near-net-shape parts made by precision casting, forming, or powder-metallurgy products. **[4]**

(c)(i) A 7.5-mm-diameter drill is used on a drill press operating at 300 rpm. If the feed is 0.125 mm/rev, what is the material removal rate (MRR)? **[5]**

(ii) What is the MRR if the drill diameter is doubled? **[4]**

(c) An orthogonal cutting operation is being carried out under the following conditions: t_o = 0.1 mm, t_c = 0.2 mm, width of cut = 5 mm, V = 2 m/s, rake angle = 10°, F_c = 500 N, and F_t = 200 N. Calculate the percentage of the total energy that is dissipated in the shear plane. **[8]**

QUESTION THREE

(a) Identify and explain with the aid of sketches the four main chip formation systems from machining operations. **[16]**

(b) Describe in detail your thoughts regarding the physical, technical and economic factors involved in tool-material selection. **[12]**

SECTION B

QUESTION FOUR

(a) Under what circumstances would you select the following manufacturing processes? Justify fully.

(i) Injection moulding, **[6]**

(ii) Additive manufacturing / 3D printing **[6]**

(b) What are hybrid manufacturing process chains? **[2]**

(c) For the part shown in Figure Q4, suggest and justify a suitable manufacturing process chain. **[11]**

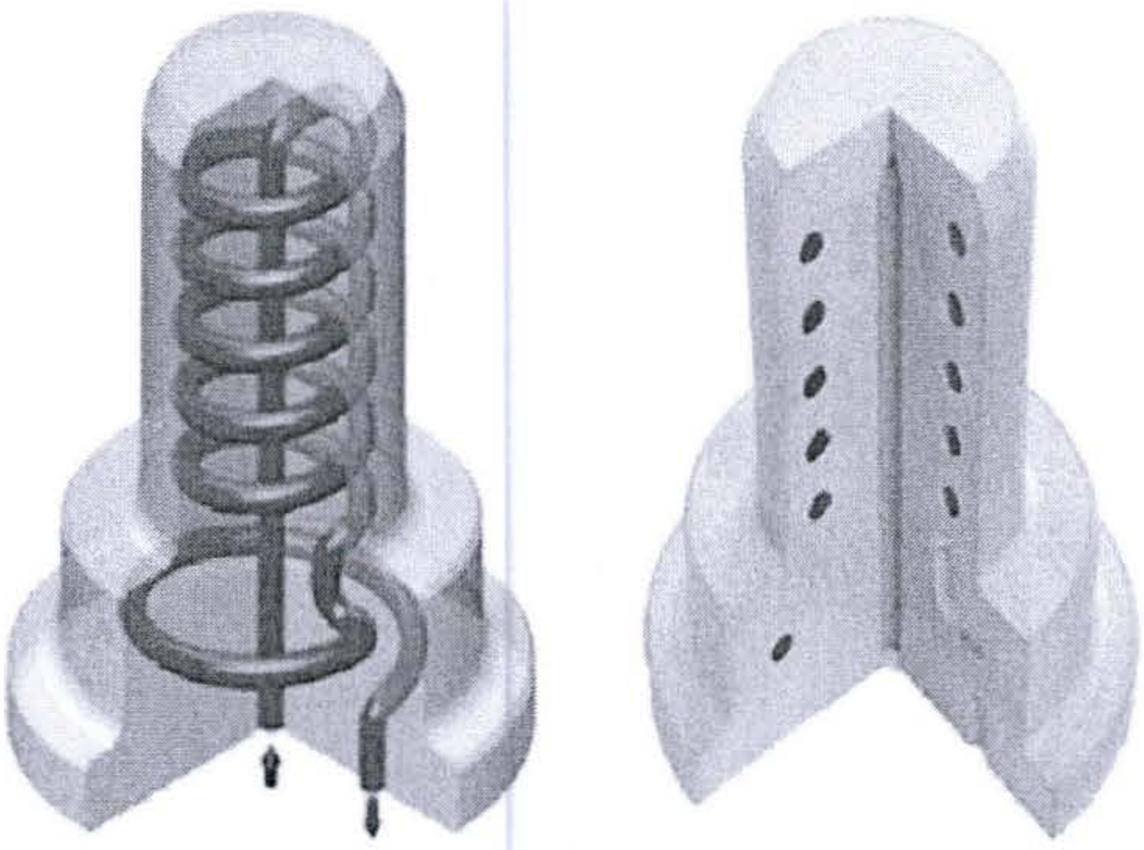

Figure Q4: Large injection moulding tool with conformal cooling channel

QUESTION FIVE

(a) How does rapid prototyping differ from rapid manufacturing? **[2]**

(b) With the aid of cited typical examples, explain the sense in which rapid prototyping and manufacturing complement traditional manufacturing technologies?. **[8]**

(c) Suggest and fully justify the most ideal building orientation for the metal part shown in Figure Q5 given that it is to be manufactured via selective laser melting. **[15]**

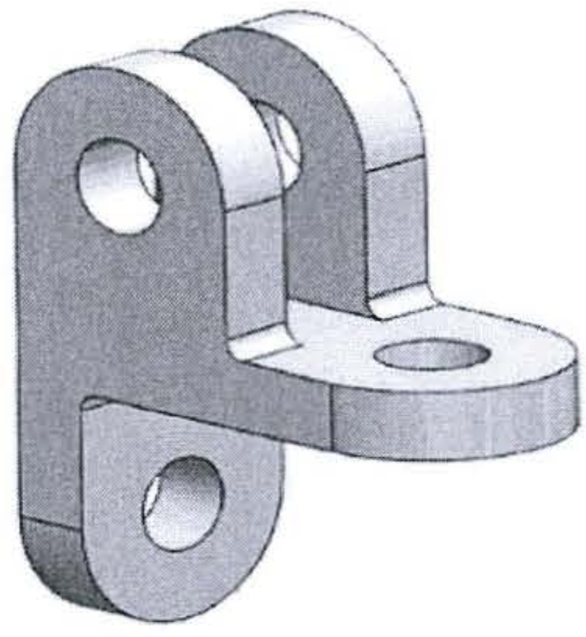

Figure Q5: Simple metal part

QUESTION SIX

(a) Most metal additive manufacturing methods utilise laser beams to melt the material feedstock. Explain why their adoption is more widespread when compared to electron beams. **[3]**

(b) Additive Manufacturing (AM) is used to build near net and net-shaped products, usually of complex geometric profiles. This includes direct manufacturing as well as direct and indirect tooling. However, this is not the exclusive application of AM. Identify and describe an application that would make AM attractive, apart from new product manufacturing or prototyping. **[8]**

(c) Describe the two (2) common techniques used for AM-grade metal powder manufacturing. **[7]**

(d) Identify and describe the application of lasers in material property modification post additive manufacturing. **[7]**

End of Examination