NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

MASTER OF MANUFACTURING ENGINEERING AND OPERATIONS MANAGEMENT

MANUFACTURING TECHNOLOGY

TIE 6122

Stage 1 Special Supplementary Examination Paper

March 2025

This examination paper consists of 3 printed pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Dr Nicholas Tayisepi (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

Water Jet Machining, Ultrasonic Machining, Laser Beam Machining, Electro Beam Machining, Oxygen Cutting Machining, Plasma Arc Cutting, Electrical Discharge Machining, Wire Electrical Discharge Machining, Electro-Chemical Machining, Chemical Machining are some of the established non-conventional machining manufacturing methods being utilised in the industry and in research work currently. Comprehensively discuss any two of these non-conventional machining methods as they are being used as technology in the manufacturing of products today. [25]

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) The choice of a manufacturing process is critical as it determines the performance of the end product. Discuss [5]

(b) Briefly describe the following polymer processing methods, stating their applications:

(i) Extrusion [5]

(ii) Rotational moulding [5]

(iii) Blow moulding [5]

(c) Write short notes on incremental sheet metal forming [5]

QUESTION FIVE

(a) What do you understand by the following terms:

(i) Rapid prototyping, [3]

(ii) Rapid manufacturing [2]

(iii) Rapid tooling. [2]

(b) Describe and explain any three (3) instances where Additive Manufacturing (AM) would be preferred over conventional manufacturing processes? [15]

(c) Why is it not possible to process thermosetting materials using Fused Deposition Modelling (FDM)? [3]

QUESTION SIX

(a) What rule(s) apply when building overhangs using additive manufacturing (AM)? [2]

(b) One of the setbacks of Metal Additive Manufacturing (MAM) methods is residual stresses. Why are these stresses prominent in MAM compared to other manufacturing processes? [4]

(c) The Electron beam melting is strictly carried out in a vacuum chamber. Explain the reason(s) for this. [4]

(d) Describe fully the process of Selective Laser Melting (SLM) [10]

(e) Surface roughness in parts manufactured using AM can both be desirable and non-desirable. Discuss. [5]

End of Examination