NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

MASTER OF MANUFACTURING ENGINEERING/SYSTEMS AND OPERATIONS MANAGEMENT

COMPUTER AIDED DESIGN/COMPUTER AIDED MANUFACTURING (CAD/CAM)

TIE 6121

STAGE 1 SPECIAL SUPPLEMENTARY EXAMINATION PAPER

MARCH 2025

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Dr Nicholas Tayisepi (Pr Eng)

INSTRUCTIONS AND INFORMATION TO CANDIDATE

Answer FOUR questions, TWO from each Section, out of SIX.
All Questions carry equal marks (25)
Show all working where required. Clarity and neatness shall be credited

SECTION A

QUESTION ONE

(a) A cubic polynomial of the general form in the Hermite basis function is given by equation:

$$\overline{p} = \overline{p}(u) = \overline{p}_O(1 - 3u^2 + 2u^3) + \overline{p}_1(3u^2 - 2u^3) + \overline{p}_o^{\,1}(u - 2u^2 + u^3) + \overline{p}_1^{\,1}(-u^2 + u^3)$$

Derive the equation for Bezier cubic polynomial. Illustrate your answer with appropriate diagrams.   **[10]**

(b) Calculate a parametric point on a Hermite cubic curve that fits parameter U = 0.3 and P_o= (2,2) P_1 = (10,12) P^1_o= (0,3) P^1_1 = (3,0)   **[5]**

(c) Briefly explain four main stages of the design process. Illustrate with Pahl-Beitz or Ohsuga model of design process diagram detailing all stages indicating the inputs and outputs for each stage.   **[10]**

QUESTION TWO

(i)   Site practical examples in explaining, why analytical equations in explicit and implicit forms are not suitable for representing geometry in CAD.   **[5]**

(ii) Explain the concept of parametric representation of geometric entities giving an example of a typical equation.   **[5]**

(iii) Discuss the merits of parametric form of representation over analytical forms of feature representation in CAD.   **[5]**

TIE 6121

(iv) How many parameters are needed to describe the following in 3D space? Illustrate with simple diagrams:

   (a) a curve [3]

   (b) a surface [3]

   (c) a solid [4]

QUESTION THREE

(a) Discuss Constructive Solid Geometry (CSG) concept detailing with illustrations the Binary Tree concept, defining root, leaf, parent and child nodes. [5]

b) Use CSG method to construct a general binary tree (with circles representing nodes) and diagrammatic binary tree (using primitives as building blocks step by step) for the model in Figure QU2(b). State the height of the binary tree. [5]
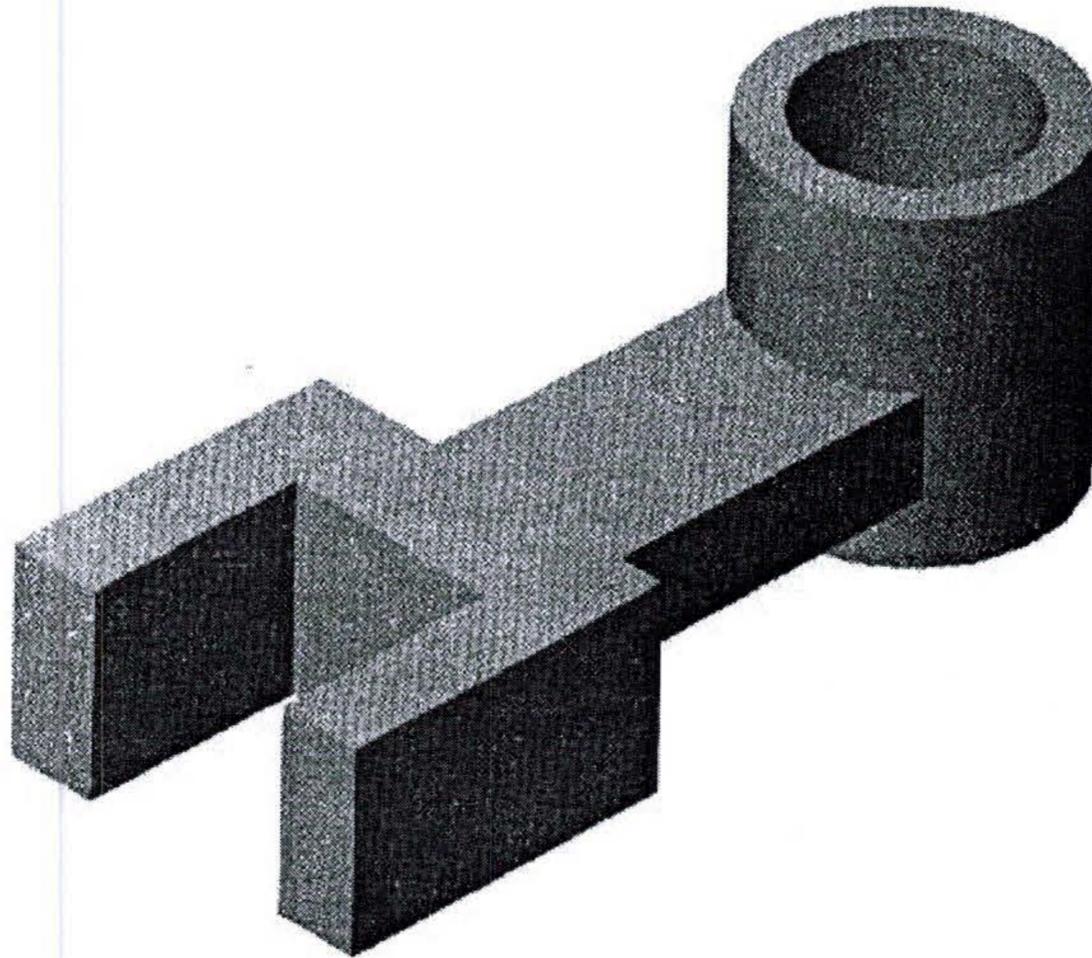
TIE 6121

Figure QU2(b)

(c) Analyze for topological consistency the model in Figure QU2(c). Present your analysis in form of a table showing the number of vertices, edges, faces, holes, passages, etc. for each element of the model. State, if the model is topologically consistent or not. **[7]**
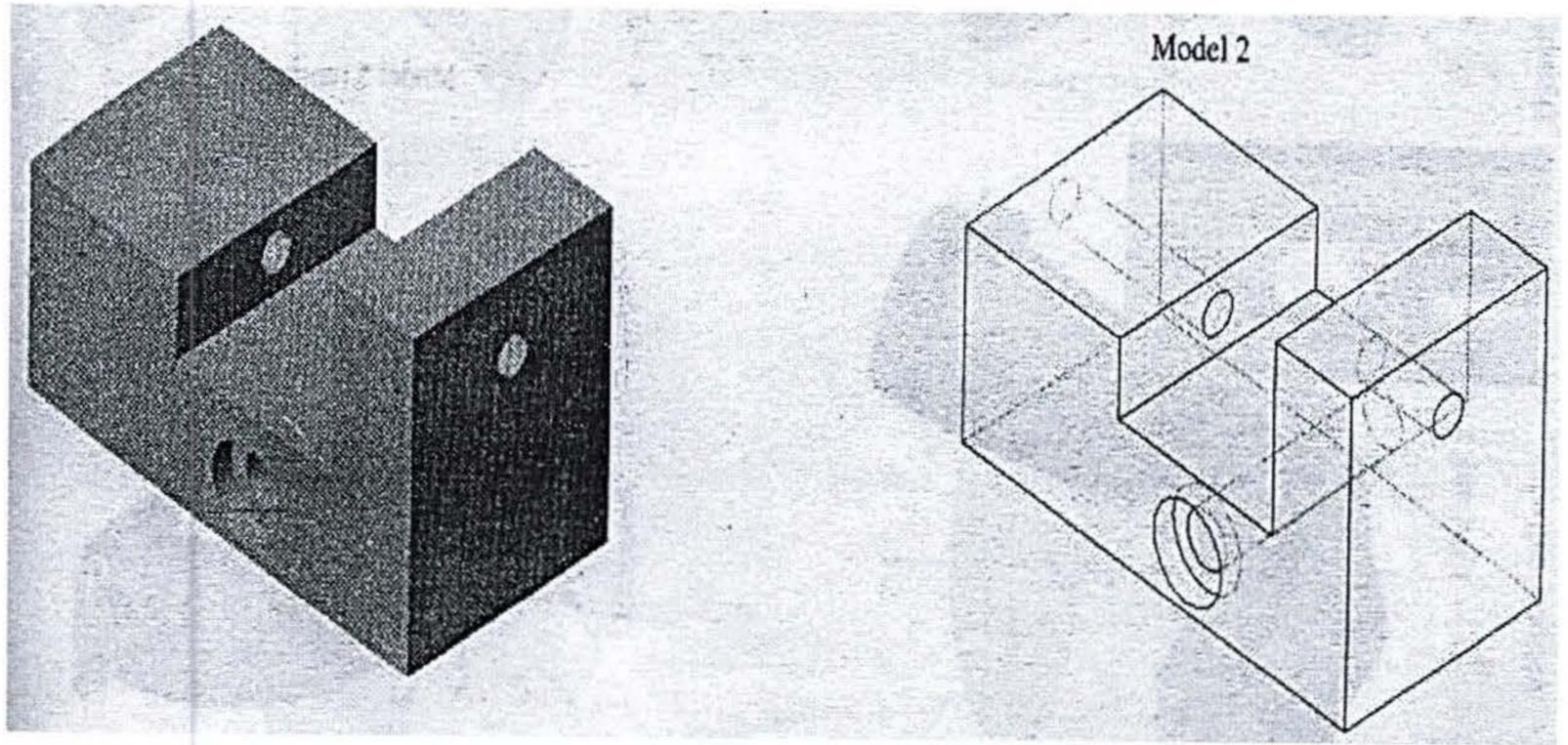
TIE 6121

Model 2

Figure QU2(c)

(d) Define Local Area Network (LAN) and Sketch basic types of the following LAN arrangements:

(i) Star **[2]**

(ii) Bus **[2]**

(iii) Ring **[2]**

(iv) tree **[2]**

SECTION B

QUESTION FOUR

a) Briefly explain the difference between parametric design and variational design.

[10]

b) Write a concise part program to machine the component shown in Figure QU4. Given details are that the milling tools, T202 and T101 operates with a feedrate F = 80 mm/min and the spindle speed S=1392 rev/min while the drilling tool T4 and T5

TIE 6121

operates with a feedrate F = 120 mm/min and spindle speed S = 1193 rev/min. For the outer profile use G41. **[15]**
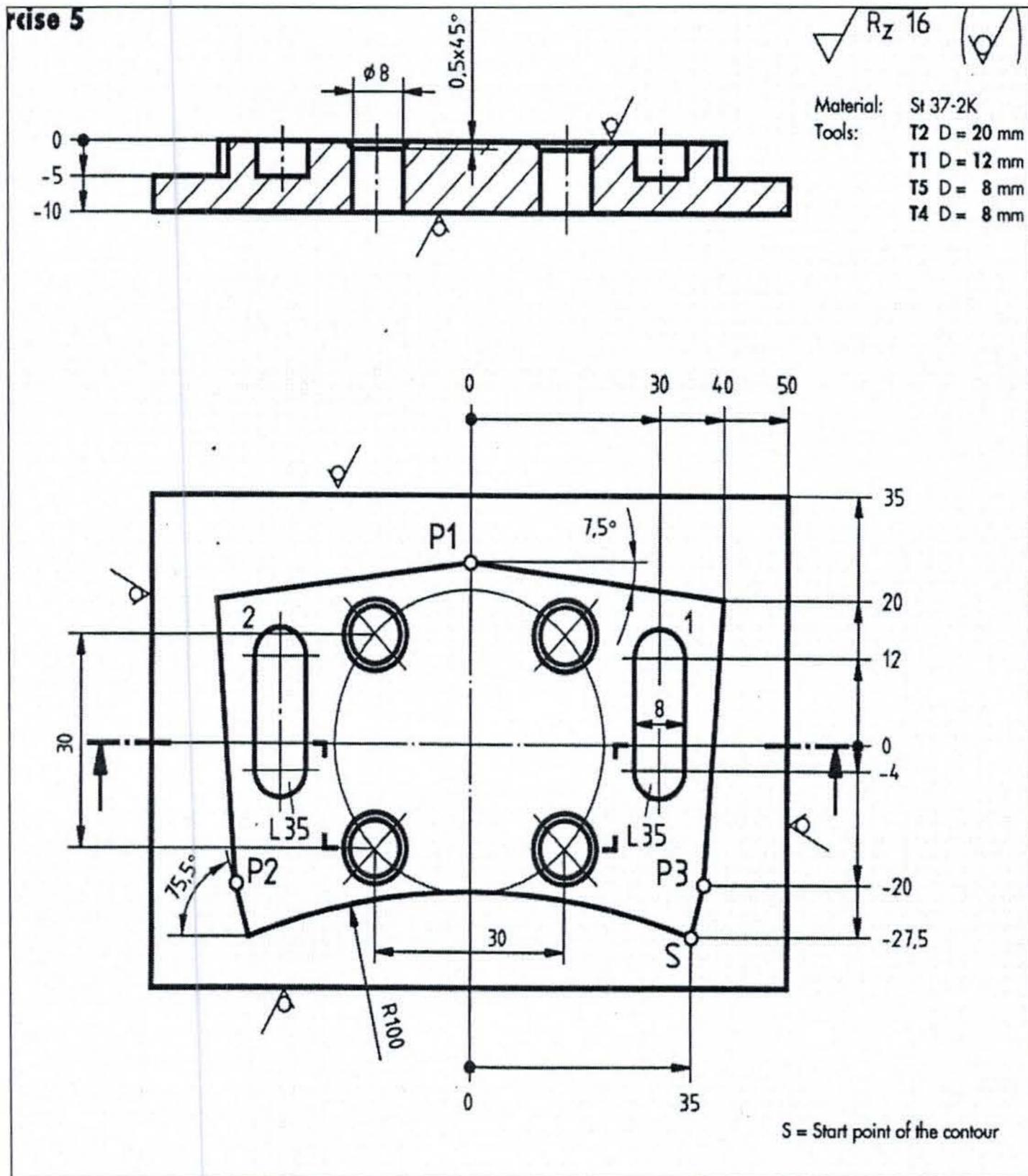

Figure QU4

S = Start point of the contour

TIE 6121

QUESTION FIVE

a) Discuss the two types of process planning systems. **[10]**

b) Write a concise part program to machine the component shown in Figure QU5, given that the Feed rate F=0.4 and the spindle speed S = 560 rev/min using a tool T0101 and T0202 for roughing to 0.2mm of final dimensions, while Feed rate F=0.15 and the spindle speed S = 780 rev/min using a tool T0303 for finishing. Assuming that the blank is 100 mm x D60. **[15]**
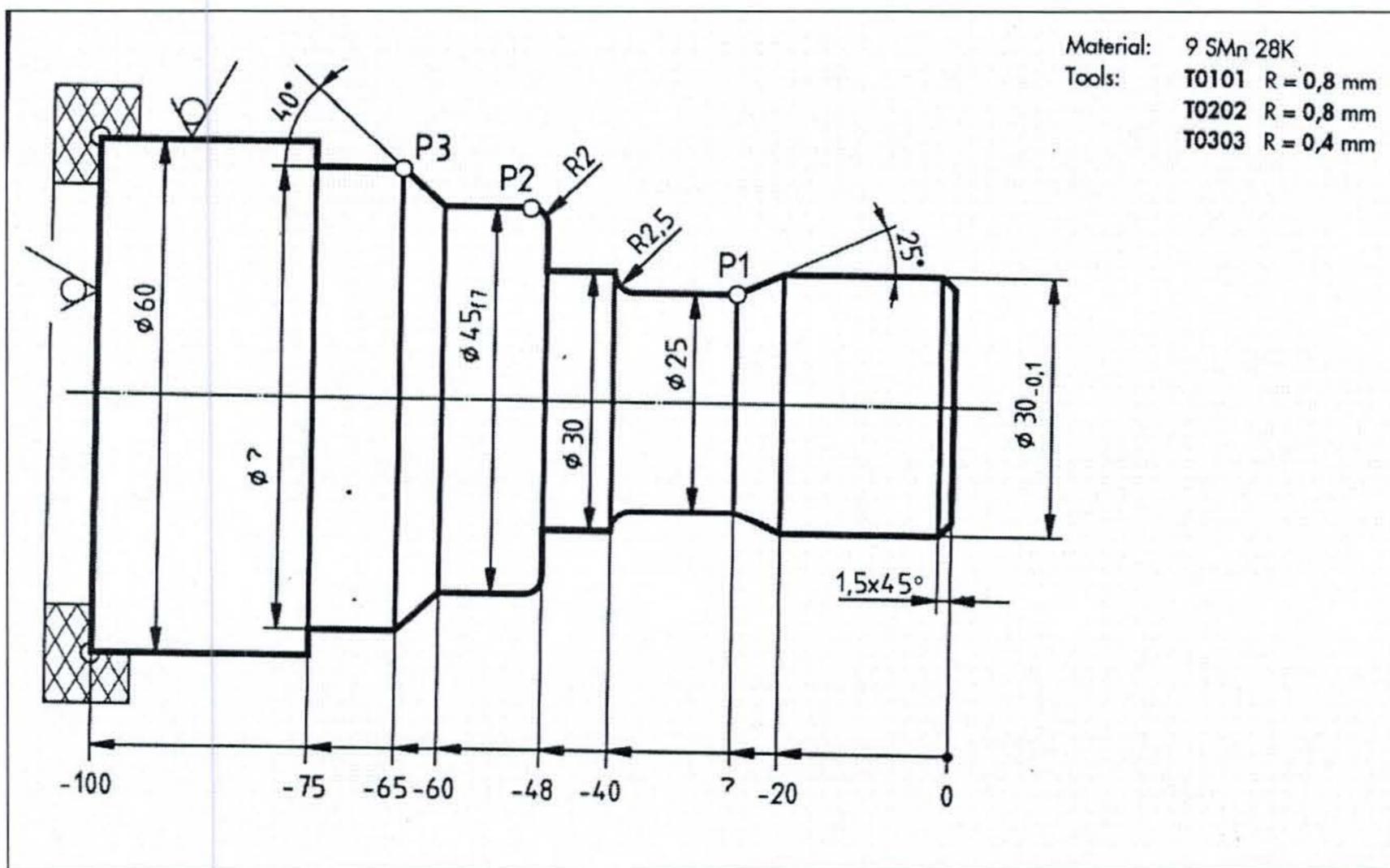

Figure QU5

TIE 6121

QUESTION SIX

a) Briefly discuss Feature Recognition in CAPP systems.   **[10]**

b) Write a full APT program for machining of the profile for the part given in Figure QU6. The dimensions of the stock material are 250 x 150 x 10mm. Given data: milling tool T102 with diameter D = 10 mm, Feed rate F = 80 mm/min and spindle speed S = 760 rev/min. Any other information not given can be assumed and stated in solution.   **[15]**
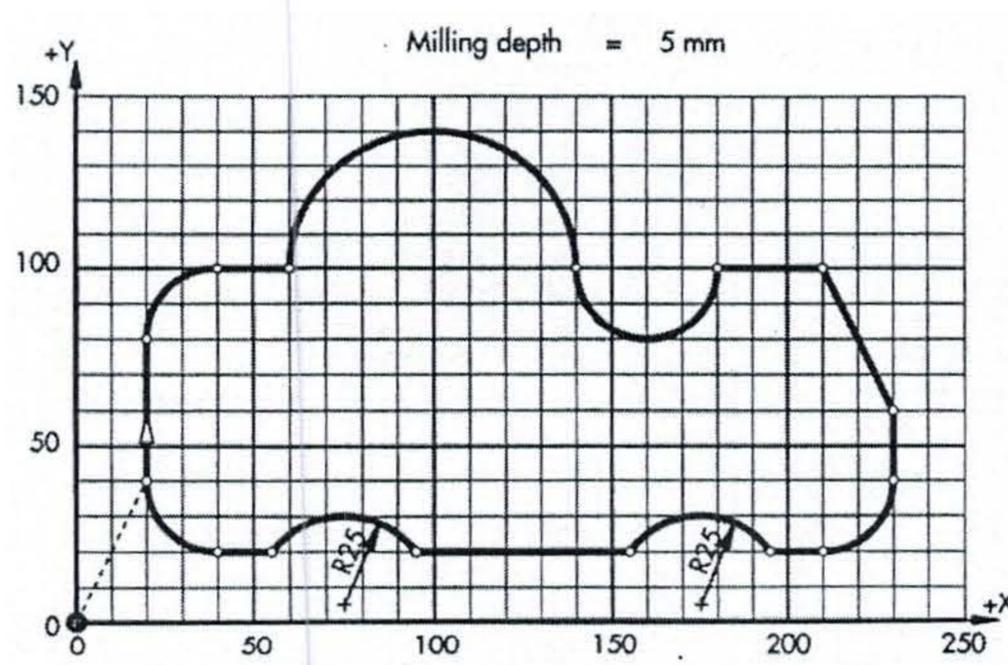

Figure QU6

....End of Exam...
P

TIE 6121