



# MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 511: COMPUTER-AIDED MANUFACTURING

DATE:

TIME:

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## INSTRUCTIONS

- This paper contains **FIVE (5)** questions.
- You are required to answer **THREE (3)** questions only.
- Question **one** is compulsory.
- Attempt any other two questions.
- Question one carries 30 marks and the others carry 20 marks each.

## QUESTION ONE (30 MARKS)

- a) Explain the meaning of the term CAM and explain any FOUR disadvantages of the it (5 marks)
- b) The CAD system has three major parts. Using a sketch, explain any THREE functions of each part (5 marks)
- c) Discuss the application of Finite Element Analysis in structural analysis, thermal analysis and manufacturing simulation and optimization. (6 marks)
- d) The motor shaft is directly connected to the leadscrew for driving an NC machine table. The leadscrew has a step angle of  $1.8^\circ$ . If the pitch of the leadscrew is 2.5mm,
- i) determine how closely the table's position can be controlled. (2 marks)
  - ii) Suppose we want to move the table at 120 mm/min. What would be the rotational speed of the motor and the pulse frequency? (4 marks)
- e) A group of students were required to milled a rectangular metal plate from a big mild steel block for use in the laboratory exercises. The metal plate of dimensions of 110 mm x 60 mm x 6 mm is to be milled using 8 mm end milling cutter at a speed of 1200 rpm in a feed rate of 100 mm/minute. The initial starting point will be set up at the lower left corner of

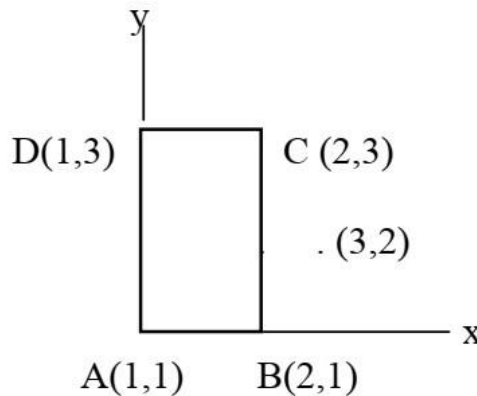
the rectangle at point (150, 150). Write a simple CNC part program with its explanation in a tabular format to milled the rectangular metal block. (8 marks)

**QUESTION TWO (20 MARKS)**

- a) Explain the TWO types of transformations as applied in geometric modelling (2 marks)
- b) Show that the transformation matrix of a point rotated about the z-axis in a counterclockwise direction and passes through the origin is given by: (3 marks)

$$T = \begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix}$$

- c) Rotate the rectangle formed by points A(1,1), B(2,1), C(2,3), and D(1,3) 30° ccw about the point (3,2). (4 Marks)



- d) Discuss the application of Finite Element Analysis in structural analysis, thermal analysis and manufacturing simulation and optimization. (6 marks)
- e) With help of a well labelled sketch, explain the basic components of an industrial robot (5 marks)

**QUESTION THREE (20 MARKS)**

- a) A cubic Bezier curve is described by the four control points: (0; 0), (3; 2), (6; 3), (8; 1). Find the tangent to the curve at t = 0.2. (5 marks)
- b) Solid modelling is a superior method compared to other modeling techniques. Explain any FIVE reasons for its superiority State the advantages and disadvantages of each. (5 marks)
- c) Explain the classification of surfaces in CAD giving relevant examples (4 marks)
- d) To transfer data from one CAD system to another, or between CAD and CAM packages, a standard data exchange format is very important. Explain any TWO types of standard data exchange format? (2 Marks)
- e) Describe FIVE factors considered when selecting an industrial robot for use (5 marks)

**QUESTION FOUR (20 MARKS)**

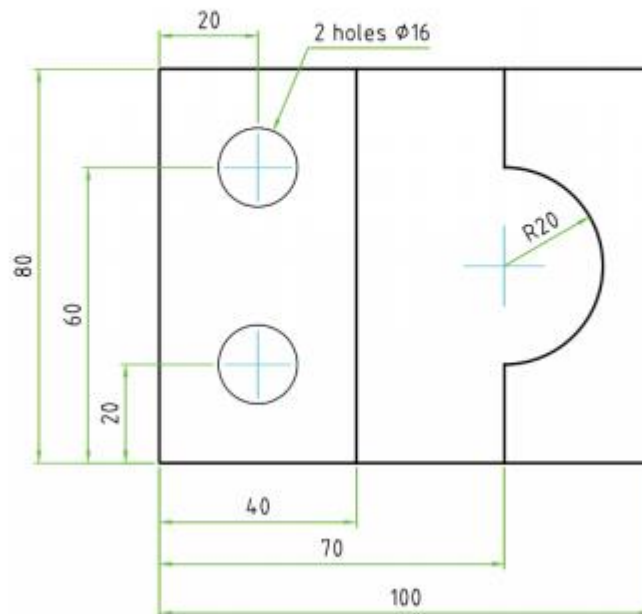
- a) A parametric cubic curve passes through the points (0, 0), (2, 4), (4, 3), (5, -2) which are parametrized at t = 0, 1/4, 3/4, and 1 respectively. Determine the geometric coefficient matrix and the slope of the curve when t = 0.5. (5 Marks).

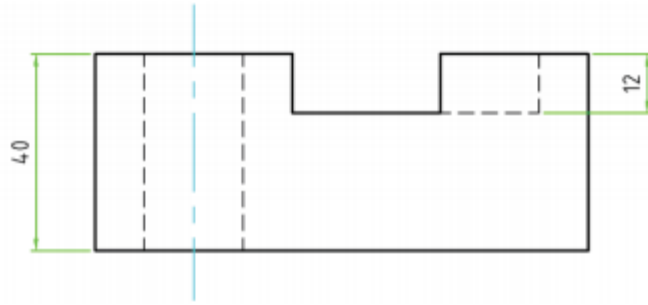
- b) Define a robot and with the aid of a diagram describe the parts of a robot (6 marks)
- c) Differentiate between SCARA and Gantry robot, include a diagram to illustrate (4 marks)
- d) Describe five advantages of CNC machine over the conventional machining methods. (5 marks)

**QUESTION FIVE (20 marks)**

- a) Describe what we mean by parametric design technique. (2 marks)
- b) Explain five steps to be followed in the iterative design process (5 marks)
- c) Fifth-year mechanical students are to optimize an experiment using parametric design. Describe in detail four parametric techniques. (4 marks)
- d) The figure below shows the part that is to be machined from 100 by 80 by 40 mm billet. A three-axis CNC machine is to be used for the process. Write a part program that can be used to effectively machine the part. The cutting parameters are given in a table. (9 marks)

	<i>Milling</i>	<i>Drilling</i>
<i>Cutter</i>	$\phi 20\text{mm}$ flat end mill	$\phi 16\text{mm}$ drill bit
<i>Spindle speed (rpm)</i>	3000	500
<i>Feed (mm/min)</i>	500	240





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