



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN (MECHANICAL ENGINEERING)

EMM 511: COMPUTER AIDED DESIGN/COMPUTER AIDED

MANUFACTURING (CAD/CAM)

DATE:

TIME:

INSTRUCTIONS

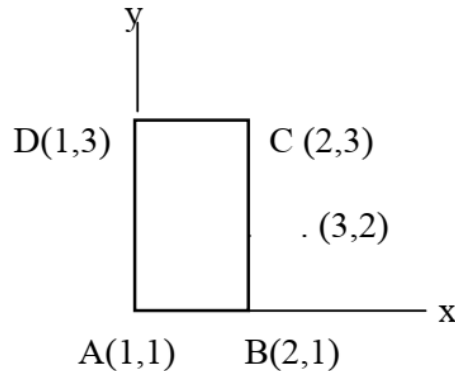
1. This Paper contains **FIVE** questions.
2. Question 1 (**ONE**) is **COMPULSORY**.
3. Answer **Question 1** and any other **TWO** questions.

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define CAM and explain **THREE** key components of an operative CAM system (4 marks)
- b) State **THREE** applications where CAM is used directly in manufacturing process. (3 marks)
- c) A parametric cubic curve passes through the points (0, 0), (2, 4), (4, 3), (5, -2) which are parametrized at $t = 0, \frac{1}{4}, \frac{3}{4},$ and 1 respectively. Determine the geometric coefficient matrix and the slope of the curve when $t = 0.5$. (5 marks)
- d) Describe **FIVE** factors considered when selecting an industrial robot for use (5 marks)
- e) Explain any **FIVE** limitations of the surface modelling technique. (5 marks)
- f) Discuss the application of Finite Element Analysis in structural analysis, thermal analysis and manufacturing simulation and optimization. (6 marks)
- g) State the meaning of program input device as applied to CNC machines and state any **TWO** input devices. (2 marks)

QUESTION TWO (20 MARKS)

- a) Using a flowchart, describe a typical work-flow of CAD/CAM based part programming. (6 marks)
- b) A rectangle formed by points A (1,1), B (2,1), C (2,3), and D (1,3) as shown in Figure 2 (b) is rotated by 30° counterclockwise about the point (3,2). What are the new coordinates of points A, B, C, and D of the new rectangle after rotation? (4 marks)



- c) With help of a well labelled sketch, explain the basic components of an industrial robot (5 marks)
- d) Describe factors considered in selecting a CNC machine (5 marks)

QUESTION THREE (20 MARKS)

- a) Explain any **THREE** input devices used to feed informations to computers in CAD hardware. (3 marks)
- b) Describe the **FOUR** statements used in Automatically Programmed Tool (APT) high level programming language and give example of a word in each statement. (6 marks)
- c) Give **TWO** errors encountered in finite element modelling. (2 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° . 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) Define the term sensor and explain the functions and importance of sensors in robotic (3 marks)

QUESTION FOUR (20 MARKS)

- a) Explain any **THREE** engineering analyses that can be conducted within CAD environment (3 marks)
- b) State the meaning of the following codes as used in CNC part programming (3 marks)

Code	Meaning
G91	
I5	
F150	
S1200	
M04	
M06	

- c) Describe **FOUR** ways of programming a robot (6 marks)
- d) A group of students were required to mill a rectangular metal plate from a big mild steel block for use in the laboratory exercises. The metal plate of dimensions of 100 mm x 50 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 mill the rectangular metal block. (8 marks)

QUESTION FIVE (20 MARKS)

- a) Explain **THREE** types of parametric surfaces as used in surface modelling. (4 marks)
- b) Briefly describe the following solid representation schemes used in CAD systems.
- (i) Constructive solid geometry (CSG) (2 marks)
 - (i) Boundary representation (B-rep) (2 marks)
- c) State any **THREE** major modelling transformations as used in computer graphics. (3 marks)
- d) State any **FOUR** factors that have inhibited the growth of manufacturing automation despite of their enormous benefits (4 marks)
- e) Highlands Mineral Water Company Ltd in Nyeri is considering the acquisition of a robot to speed up juice production. The robot is to pick up crates of small liquid bottles from a conveyor and stack them onto a waiting Automatically Guided Vehicle (AGV), which docks at a fixed position. Stacking is done such that the crates have to fit into each other precisely. Each crate weighs 500kg. The cost of the preferred robot must be kept at a minimum. As a graduate trainee employed at the company, give a technical description of the **most** ideal robot to be used in the set-up described above. (5 marks)