



MACHAKOS UNIVERSITY

University Examinations 2023/2024 Academic Year

SCHOOL OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF MECHANICAL & 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 (30 MARKS)

- a) Define CAM and explain **THREE** key components of an operative CAM system.
(4 Marks)
- b) 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)
- c) Describe **FIVE** factors considered when selecting an industrial robot for use.
(5 Marks)
- d) Discuss the application of Finite Element Analysis in structural analysis, thermal analysis and manufacturing simulation and optimization.
(6 Marks)
- e) Figure **Q1 (e)** shows a part to be machined on a CNC turning center running on a Fanuc compatible control. Write a CNC code to machine the part and explain each line of the program. All units are in inches. Use absolute programming, surface speed of 500 SFM, depth of cut of 0.1 inches and feed rate of 0.008 Inches per Rev for the roughing operation. For the finishing cut use a feed rate of 0.005 Inches per Rev, surface speed of 300 SFM and depth of cut of 0.050 inches. Assume the

material being machined is brass.

(10 Marks)

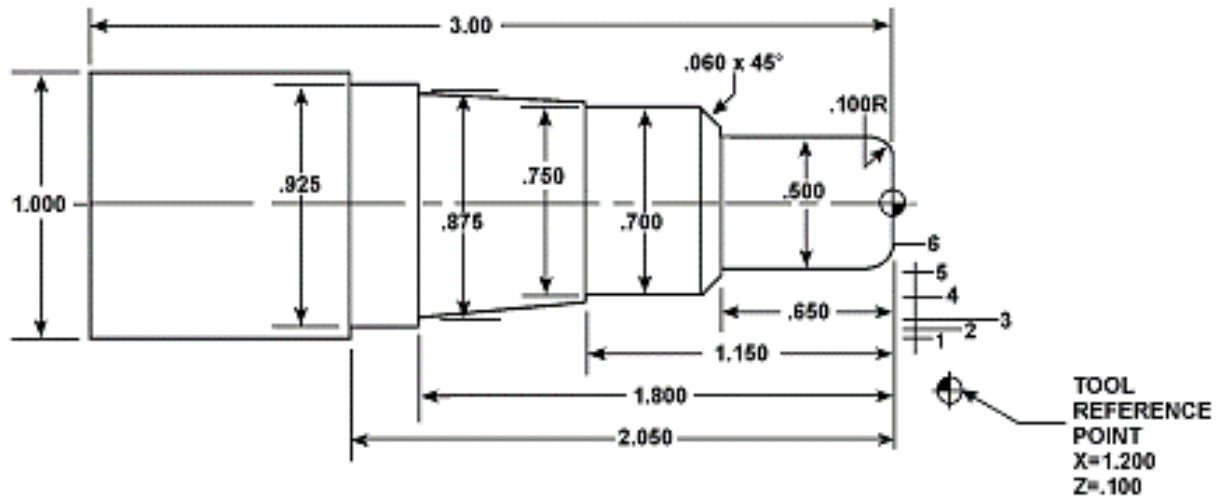
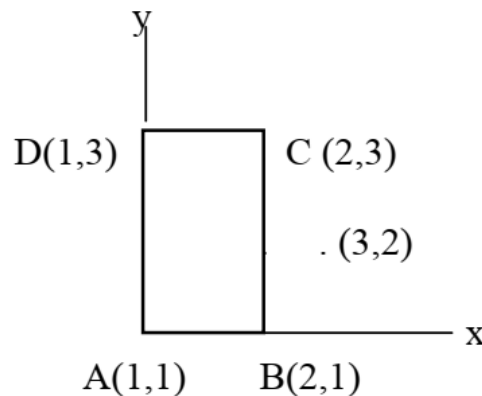


Fig Q (1e)

QUESTION TWO (20 MARKS)

- Using a flowchart, describe a typical work-flow of CAD/CAM based part programming. **(6 Marks)**
- 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)**



- With help of a well labelled sketch, explain the basic components of an industrial robot. **(5 Marks)**
- 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) Show that the cutting speed of a milling machine is given by: **(4 marks)**

$$Speed \left(\frac{rev}{min} \right) = \frac{SFM \left(\frac{ft}{min} \right) \times 3.82}{Dia(in)}$$

- e) Calculate the cutting speed and feed for a milling operation given the following values: **(5 Marks)**

Parameter	Value
Tool Diameter	.500in
Num Flutes	4
SFM	600ft/min
IPR	.005in

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) Figure Q4 (c) shows a profile to be machined on a three axes CNC milling machine. Write a CNC code to machine the profile explaining each line of code. Use a feed rate of 50mm/min and cut a depth of 5mm. Assume material being cut is Perspex. (6 Marks)

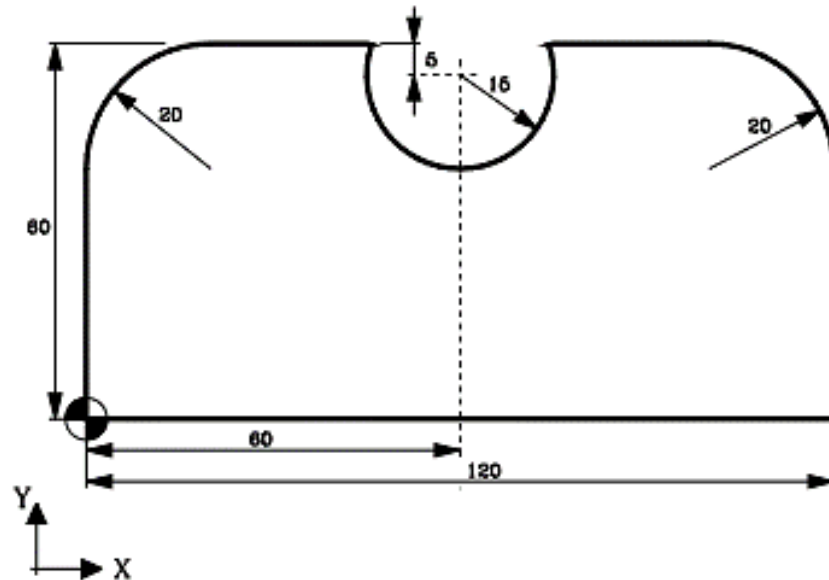


Fig Q 4 (c)

- d) 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 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 milled the rectangular metal block. (8 Marks)

QUESTION FIVE (20 MARKS)

- Explain **THREE** types of parametric surfaces as used in surface modelling (3 Marks)
- Briefly describe the following solid representation schemes used in CAD systems.
 - Constructive solid geometry (CSG) (2 Marks)
 - Boundary representation (B-rep) (2 Marks)
- State any **THREE** major modelling transformations as used in computer graphics. (3 Marks)
- State any **FOUR** factors that have inhibit 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.

(6 Marks)