MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIFTH YEAR SPECIAL/SUPPLIMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 511: COMPUTER AIDED DESIGN/COMPUTER AIDED MANUFACTURING (CAD/CAM)

DATE: 25/3/2021 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

This paper contains FIVE questions

Question ONE is compulsory and carries 30 Marks while the rest carries 20 Marks each. Attempt any two.

QUESTIONS ONE (30 MARKS)

a) What are the three types of CAD application software? Give examples (3 marks)

b) Describe 3 constituents of a CAD system (6 marks)

c) Describe the main elements in a CNC system (3 marks)

d) What are the merits and demerits of CAD/CAM? (4 marks)

e) What do you understand by input and output devices as far as CAD hardware systems are concerned? (2 marks)

f) Define an industrial robot (2 marks)

g) Name three most widely accepted CAD data exchange formats and discuss their importance (3 marks)

h) Discuss any four types of engineering analysis that can be conducted within CAD environment (4 marks)

i) State three applications of the computer in direct manufacturing control and monitoring (3 marks)

QUESTIONS TWO

a) Define Finite Element Analysis (2 marks)

b) Finite element analysis (FEA) finds application in a wide range of engineering problems/areas. State six such problems/areas (3 marks)

c) Describe in detail, the three stages in Finite Element Analysis (6 marks)

d) With the aid of sketches, name two 3D elements available in commercial FEA softwares (2 marks)

e) What is the importance of carrying out analysis of a mechanical part or assembly in the design phase? (3 marks)

f) Describe the four main inputs into a finite element program (4 marks)

QUESTIONS THREE

a) A line with end points A (2, 3, 2) and B (10, 12, 8) is rotated 60° counter clockwise about the z-axis, then translated by a vector $[5\ 4\ 8]^T$ and finally scaled by (S_x, S_y, S_z). If the final coordinates of point A are A' (6.8, 14.46, 20.0) determine the scaling factors and hence the coordinates of point B'. (8 marks)

b) Describe the following types of 3-D modelling techniques. Cite an example of its application, advantages and disadvantages for each.

i. Surface modelling (6 marks)

ii. Solid Modelling (6 marks)

QUESTIONS FOUR

a) Define the term "Numerical Control" (2 marks)

b) With the aid of sketches, differentiate between absolute and incremental positioning in CNC programming (4 marks)

c) Figure Q4(c) is an illustration of a billet that is to be milled on a three axis CNC machine. Using the program table format provided in Table 1, write a program that can be used to effectively mill the profile. (14 marks)

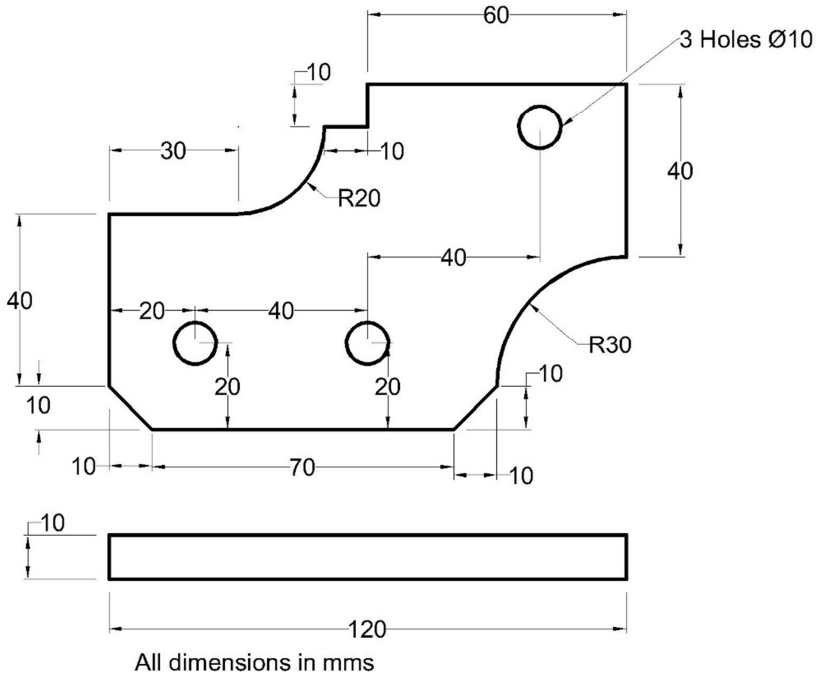

Figure Q4(c)

Spindle speed 1500 rpm for milling and 1200rpm drilling
Feed rate 100 mm/min (for both milling and drilling)

Table 1. NC part program manuscript

Description	N	G	G	G	X	Y	Z	R	I	J	K	M	T	D	S	F

QUESTION FIVE

a) Describe four applications of industrial robots (4 marks)

b) Describe the following robot configurations;

i. Spherical (2 marks)

ii. Cylindrical (2 marks)

iii. Rectangular (2 marks)

c) Describe two limitations of the wireframe model (2 marks)

d) Describe the function of a graphics user interface (GUI) (2 marks)

e) Describe the major phases in the history and evolution of CAD/CAM package

(6 marks)

Appendix

Rotation about z

$$R_z = \begin{pmatrix} c & -s & 0 & 0 \\ s & c & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Where $c = cos\ \theta$

$s = sin\ \theta$

Translation matrix

$$T_r = \begin{pmatrix} 1 & 0 & 0 & dx \\ 0 & 1 & 0 & dy \\ 0 & 0 & 1 & dz \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Scaling matrix

$$S_r = \begin{pmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Table 2: G-Codes

G00	Rapid traverse	G21	Input in mm
G01	Linear interpolation	G28	Return to reference point
G02	Circular interpolation -CW	G40	Cutter diameter compensation-cancel
G03	Circular interpolation -CCW	G41	Cutter diameter compensation-left
G04	Dwell	G42	Cutter diameter compensation-right
G08	Acceleration	G43	Tool length compensation (+)
G09	Deceleration	G49	Tool length compensation - cancel
G17	X-Y plane	G80	Canned cycle cancel
G18	Z-X plane	G81	Basic drill cycle
G19	Y-Z plane	G90	Absolute programming mode
G20	Input in inches	G91	Incremental programming mode
G94	Feed per minutes	G92	Set x, y, z locations

Table 3: M-Codes

M00	Program stop	M06	Automatic Tool change
M01	Optional program stop	M07	Flood coolant on

M02	End of program	M08	Mist coolant on
M03	Spindle on CW	M09	Coolant off
M04	Spindle on CCW	M30	Program reset and rewind
M05	Spindle off	M13	Spindle forward and coolant on