MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIFTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

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

DATE: 23/7/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTIONS ONE

a) Describe the major phases in the history and evolution of CAD/CAM (6 marks)

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

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

d) Describe the operating principle of a CRT screen (4 marks)

e) Using examples, differentiate between input and output devices in CAD hardware systems (2 marks)

f) State the definition of an industrial robot (2 marks)

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

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

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

QUESTIONS TWO

a) Discuss the three main components of a CAD package (6 marks)

b) Describe briefly the following solid representation schemes used in CAD systems

i. Spatial Occupancy Enumeration (SOE) (2 marks)

ii. Cell decomposition (2 marks)

iii. Sweeping (2 marks)

c) Finite element analysis (FEA) finds application in a wide range of engineering problems/areas. State four such problems/areas (2 marks)

d) The simply supported beam shown on figure 2a has rectangular cross-section and a uniformly distributed load on its top surface. The beam is to be analysed for stress and deformation using a CAD software with a FEA module. Using sketches where necessary, describe the workflow in carrying this analysis. (6 marks)

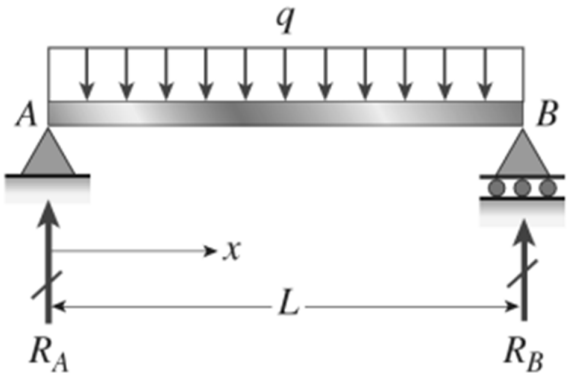

Figure Q2(a)

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)

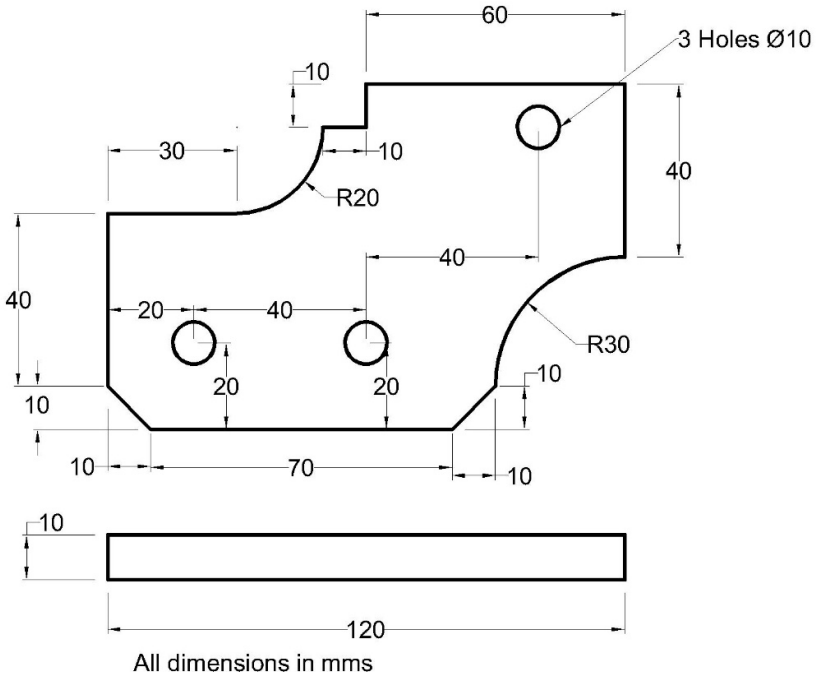

Figure Q4(c)

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) Define the term "computer graphics" (2 marks)

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

e) State the modified Euler's formula and name all the variables in the formula (3 marks)

f) Discuss any three types of engineering analysis that can be conducted within CAD environment (3 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