UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: December 2022

Module Number: ME 6302 **Module Name: Computer Aided Manufacturing**

[Three Hours]

[Answer **all questions**, each question carries twelve marks]

Q1. a) Describe how the CAM tools which are based on constituents are related to Computer Aided Manufacturing?

[3.0 Marks]

b) Name two types of rectilinear or translator drives which are used in CNC machines. Briefly describe them.

[4.0 Marks]

c) If your company asked you to manufacture a linear axis for CNC machine by using a linear motor, what are the components that you are going to use? Then describe the assembly of linear axis by using a neat sketch.

[5.0 Marks]

Q2. a) Classify the production machine categories used in modern manufacturing environment. Describe each category with the aid of neat sketches.

[3.0 Marks]

b) List five material handling functions that must be provided in a manufacturing system.

[3.0 Marks]

c) Write five factors that define and distinguish manufacturing system.

[3.0 Marks]

d) Describe the capabilities that the manufacturing system must possess for it to be flexible.

[3.0 Marks]

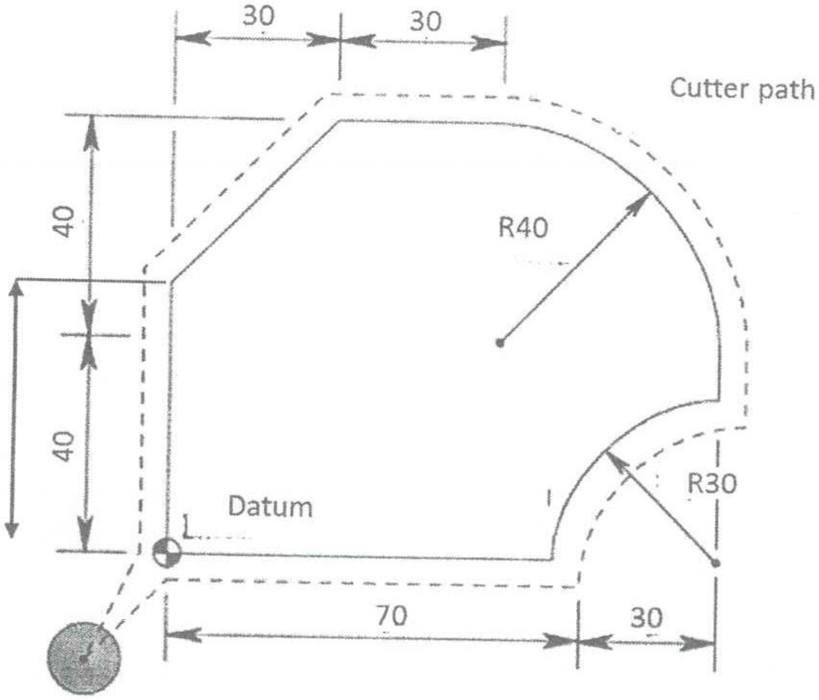
Q3 a) Write the full program for only one pass (including header and footer) to machine the part given in Figure Q3(a). You are advised to use 500mm/min as feed rate, 1000 rpm for spindle speed and the left hand cutter compensation. Use R convention for circular interpolation. The tool T01 is a flat end mill with 10mm diameter. Use 5mm above the surface as Z safe level, depth of cut as 2mm and G54 as the work origin offset. All required G codes and M codes are given in Appendix 1.

[8.0 Marks]

(Q3 continued to next page)

b) Write the program to machine two pieces of the same part in consecutive manner by using identical two work pieces. Use the body of the above program as sub program L1 and same feed rate and spindle speed. You can assume any other necessary values other than the values given. (Hint: You can use as N30 L1)

[4.0 Marks]



all dimensions are in mm

Figure Q3(a)

Q4 a) What are the conditions that you seek if you want to apply the Group Technology (GT) to an existing facility?

[1.0 Mark]

b) Write down the methods that can be used to solve the problem of grouping the parts into families. Briefly describe each and every method by emphasizing the positive and negative points.

[3.0 Marks]

c) Suppose that four machines, 1, 2, 3, and 4 have been identified as belonging in a GT machine cell. An analysis of process routings of parts on these machines has been summarized in the below part-machine incident matrix.

	Part					
Machine	A	B	C	D	E	F
1	1		1			1
2		1		1		
3	1					1
4		1		1	1	

Cluster the given machines by using rank order clustering method. Give all the steps.

[4.0 Marks]

d) An analysis of 50 parts processed on the above four machines has been summarized in the below From-To chart. Determine a logical machine arrangement using the Hollier method 1. Give all the steps.

From	To - 1	2	3	4
1	0	5	0	25
2	30	0	0	15
3	10	40	0	0
4	10	0	0	0

[4.0 Marks]

Q5 A Flexible Manufacturing System (FMS) consists of four stations. Station 1 is load/unload station with one server. Station 2 performs milling operations with three identical servers. Station 3 performs drilling operations with two identical servers. Station 4 is an inspection station with one server that performs inspections on a sampling of the parts. The stations are connected by a part handling system that has two work carriers, whose mean transport time is 3.5 min. The FMS produces four parts A, B, C, and D. The part mix fractions and process routings for the four parts are shown in the table Q5. Note that the operation frequency at the inspection station f_{4jk} is less than 1.0 to account the fact that only a fraction of parts are inspected. [Note: Average work load $WL_i = \sum_j \sum_k t_{ijk} f_{ijk} p_j$, Average number of transport $(n_t) = \sum_i \sum_j \sum_k f_{ijk} p_j - 1$, Workload of handling system $= n_t t_{n+1}$, Workload per server $= \frac{WL_i}{s_i}$, Utilization at each station, $U_i = \frac{WL_i}{s_i} \times Maximum\ production\ rate$, Overall FMS utilization , $\overline{U}_s = \frac{\sum_{i=1}^{n} s_i U_i}{\sum_{i=1}^{n} s_i}$]

Table Q5

Part j	Part mix p_j	Operation k	Description	Station i	Process time t_{ijk}	Frequency f_{ijk}
A	0.1	1	Load	1	4	1
		2	Mill	2	20	1
		3	Drill	3	15	1
		4	Inspect	4	12	0.5
		5	Unload	1	2	1
B	0.2	1	Load	1	4	1
		2	Drill	3	16	1
		3	Mill	2	25	1
		4	Drill	3	14	1
		5	Inspect	4	15	0.2
		6	Unload	1	2	1
C	0.3	1	Load	1	4	1
		2	Drill	3	23	1
		3	Inspect	4	8	0.5
		4	Unload	1	2	1
D	0.4	1	Load	1	4	1
		2	Mill	2	30	1
		3	Inspect	4	12	0.333
		4	Unload	1	2	1

Determine :

a) Maximum production rate [6.0 Marks]

b) Corresponding production rate of each part [2.0 Marks]

c) Utilization of each station [3.0 Marks]

d) The overall FMS utilization [1.0 Mark]

Appendix 1

G - Codes

G00	Rapid positioning
G01	Linear interpolation
G02	Circular interpolation CW
G03	Circular interpolation CCW
G15	Selection of work coordinate system
G17	Plane selection: XY
G18	Plane selection: ZX
G19	Plane selection: YZ
G28	Machine zero return
G40	Cutter radius compensation cancel
G41	Cutter radius compensation, Left
G42	Cutter radius compensation, Right
G53	Tool length offset cancel
G54	Work coordinate offset 1
G55	Work coordinate offset 2
G56	Work coordinate offset 3
G80	Cancel fixed cycle mode
G81	Fixed cycle, Drill/ spot boring
G83	Fixed cycle, Deep hole drilling
G90	Absolute dimensioning
G91	Incremental dimensioning

M - Codes

M03	Spindle rotation, CW
M04	Spindle rotation, CCW
M05	Spindle stop
M06	Tool change
M07	Oil mist coolant ON
M08	Coolant ON
M09	Coolant OFF
M30	End of program