UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: March 2020

Module Number: ME 6303 **Module Name: Computer Aided Manufacturing**

[Three Hours]

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

Q1. a) List the main categories of slides and guide ways which are used in CNC machines.

[2.0 Marks]

b) If two guide ways and one ball screw are supplied, by using a neat sketch, describe how you are going to fix the supplied parts to the base of a CNC machine to run X-axis of the machine. Assume that the X-axis is in horizontal position. Name all the parts.

[3.0 Marks]

c) Describe the working principle of a Linear motor. Use neat sketches with labels.

[1.0 Mark]

d) List the types of linear motors based on core and describe each and every type by emphasizing the structure. Use neat sketches with labels.

[3.0 Marks]

e) Explain the principle of detection of direction in an encoder device used in CNC machine.

[1.0 Mark]

f) Explain the semi-closed loop controlling and full-closed loop controlling principles which are used in CNC machines by means of neat sketches. Name all parts.

[2.0 Mark]

Q2. a) What are the basic steps that you have to follow before starting the manual part programming?

[3.0 Marks]

b) Write down two advantages and two disadvantages of manual part programming.

[2.0 Marks]

c) Describe absolute and incremental modes which are used in part programming. Use neat sketches with labels.

[2.0 Marks]

d) The drilling cycle is given below.

(G9Ø) (G98)
or or G81 X.... Y.... Z.... R.... F.... ;
(G91) (G99)

By using this, write a sub-program to drill the four holes defined in Figure Q2. The depth of the third hole is 25mm while others are 15mm deep. Assume that the tool is already selected. Use 2mm as the safe distance. Feed rate is 100mm/min. No need of writing the header of the program. Don't repeat the unnecessary data. All required G codes and M codes are given in Appendix 1.

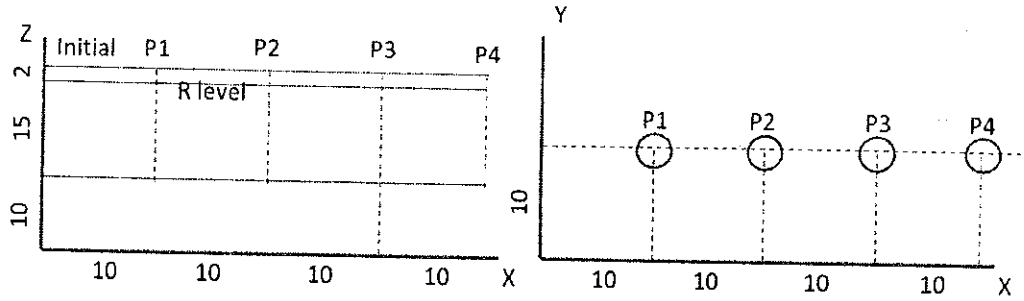

Figure Q2
all dimensions are in mm

[5.0 Marks]

Q3 a) Write the full program (Including header and footer) to machine the part given in Figure Q3-1. You are advised to use 250mm/min as feed rate and 450 rpm for spindle speed and cut by only one pass. The tool T01 is a flat end mill with 12mm diameter. Use the given point number sequence as the direction of move. Use 5mm above the surface as Z safe level and G54 as the work origin offset. All required G codes and M codes are given in Appendix 1.

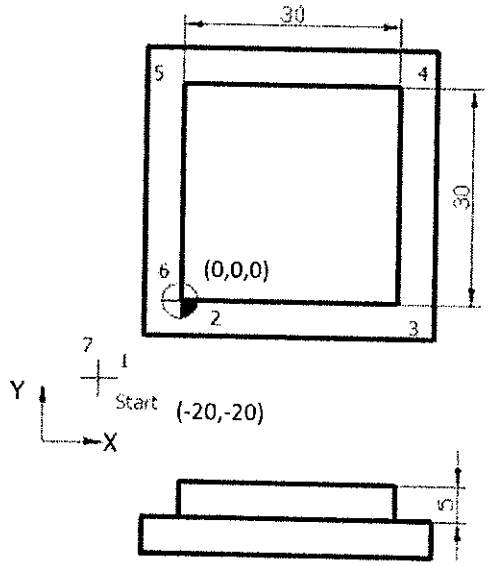

Figure Q3-1
all dimensions are in mm

[5.0 Marks]

b) Write a program to machine the groove shown in Figure Q3-2. The depth of the groove is 2mm and width of the groove is 10mm. The tool T02 is flat end mill with 10mm diameter. Start from the header of the program and use G55 as work origin offset, 500mm/min as feed rate and 2000rpm as spindle speed. Use 5mm above the surface as safe level.

[4.0 Marks]

c) Explain the way that you use to machine the two parts (a) and (b) in consecutive manner. Draw the setup of the parts on machine bed. Write the program. Use the machining sequence of programs for parts (a) and (b) as L1 and L2 (Hint: You can use as N30 L1;)

[3.0 Marks]

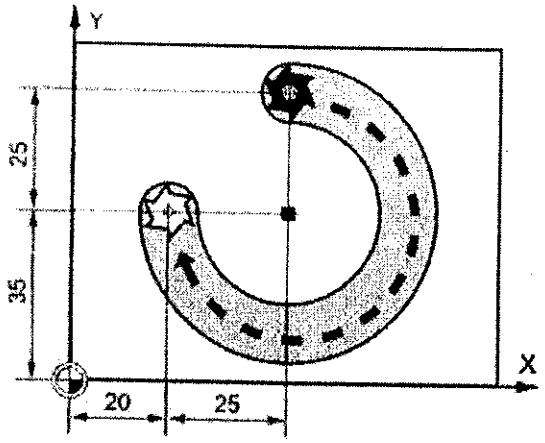

Figure Q3-2
all dimensions are in mm

Q4 a) List the conditions that the Group Technology (GT) can be applied most appropriately.

[1.0 Marks]

b) Describe the draw backs of a process type layout and the advantages of Group Technology if it is implemented instead of process type layout. Use neat sketches to elaborate your answer.

[3.0 Mark]

c) Suppose that five machines, 1 ,2 ,3, 4 and 5 have been identified as belonging in a GT machine cell. An analysis of 100 parts processed on these machines has been summarized in the below From-To chart.

	TO 1	2	3	4	5
From 1	0	0	0	0	70
2	10	0	0	0	0
3	30	0	0	70	0
4	60	0	0	0	10
5	0	60	0	0	0

i) Determine a logical machine arrangement using Hollier method 1. Give all the steps.

[4.0 Marks]

ii) Assuming that 100 parts enter to the GT machine cell at the first machine in the logical machine arrangement, draw the flow diagram for the machine cell. Identify the number of output part and the machines which give the output.

[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_{ijk} is less than 1.0 to account the fact that only a fraction of parts is inspected. [Note: Average workload $WL_i=\sum_j \sum_k t_{ijk} f_{ijk} p_j$, 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=$U_i=\frac{WL_i}{s_i} X\ Maximum\ production\ rate$, 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 :

i. Maximum production rate [6.0 Marks]
ii. Corresponding production rate of each part [2.0 Marks]
iii. Utilization of each station [3.0 Marks]
iv. 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