UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2017

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

[Three Hours]

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

Q1. a) Write down 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 parts to the base of a CNC machine to run X-axis of the machine. 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 and describe each and every type. Use neat sketches with labels. [2.0 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. [1.0 Mark]

Q2. a) A manufacturing system can be divided mainly into four components based on the constituents. List these components. [2.0 Marks]

b) Production machines can be classified mainly into three types. Write the types and briefly describe them. Use neat sketches with labels. [3.0 Marks]

c) Describe absolute and incremental modes which are used in part programming. Use neat sketches with labels. [1.0 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 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. No need of writing the header of the program. Use 2mm as the safe distance. Feed rate is 100mm/min. Don't repeat the unnecessary data. All required G codes and M codes are given in Appendix 1.

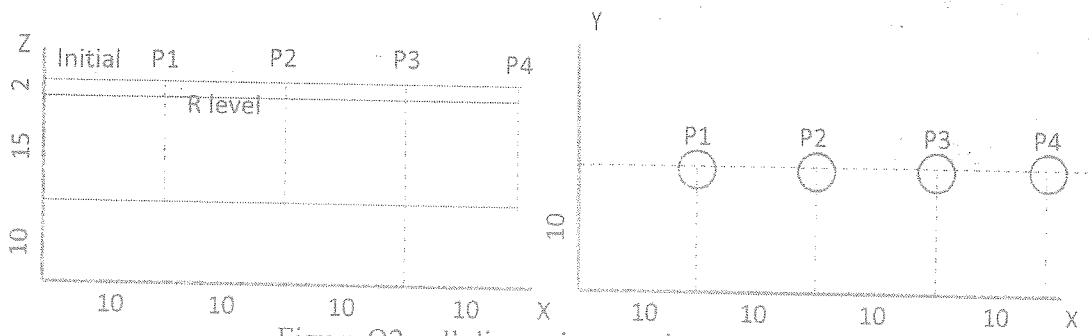

Figure Q2 –all dimensions are in mm

[4.0 Marks]

Q3 a) Write the program to machine the part given in Figure Q3-1. Start from the header of the program. 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.

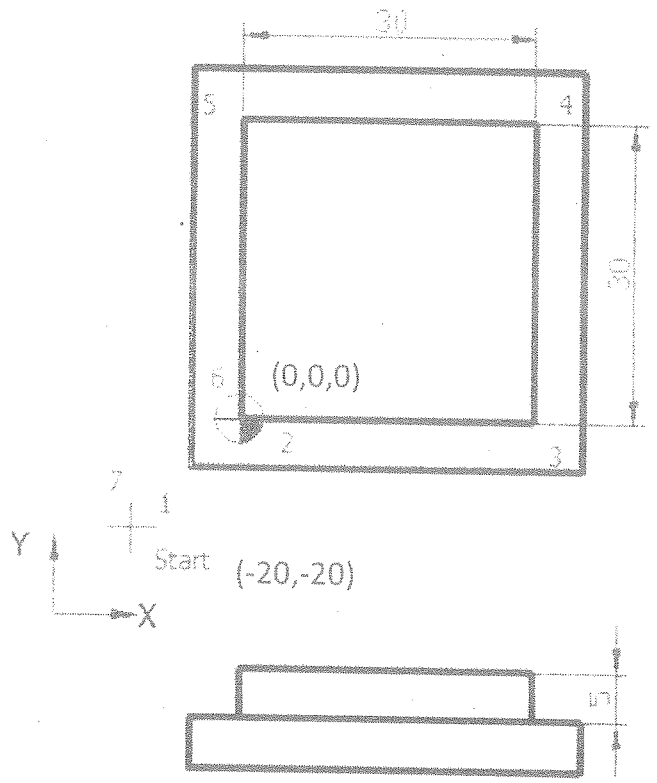

Figure Q3-1 all dimensions are in mm

[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.

[3.0 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. 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;)

[2.0 Marks]

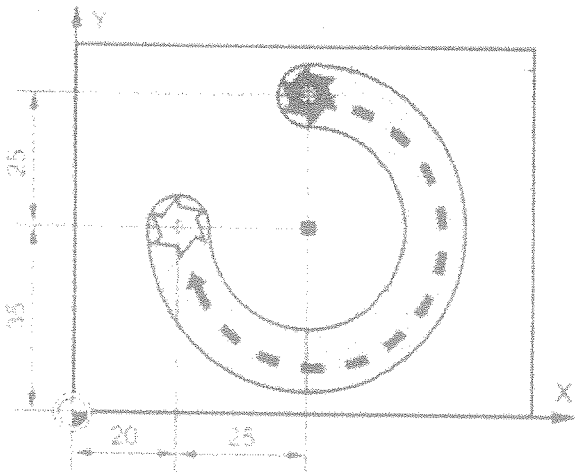

Figure Q3-2 all dimensions are in mm

Q4 a) Describe process type layout and the layout which uses group technology (GT) emphasizing draw backs of process type layout and advantages of the layout which uses GT. Draw neat sketches.

[2.0 Marks]

b) Write the methods that you can use to group the parts into families.

[1.0 Mark]

c) Part-machine incident matrix is given in Table Q4. Use rank order clustering method to find the machine clusters. Write all the steps separately

Table Q4

	Part							
Machine	A	B	C	D	E	F	G	H
1	1		1				1	
2	1		1				1	
3				1		1		
4				1				1
5		1	1		1			
6				1		1		
7		1			1			
8			1				1	

[5.0 Marks]

d) Explain the result got in part (b).

[2.0 Marks]

Q5 a) Write the criteria that can be used to check the flexibility of a manufacturing system. Briefly describe each and every criterion.

[2.0 Marks]

b) Apply the criteria in part (a) to compare the two machine cells given in Figure Q5.

[1.0 Mark]

c) List six types of flexibility in manufacturing system. Briefly describe each and every type.

[3.0 Marks]

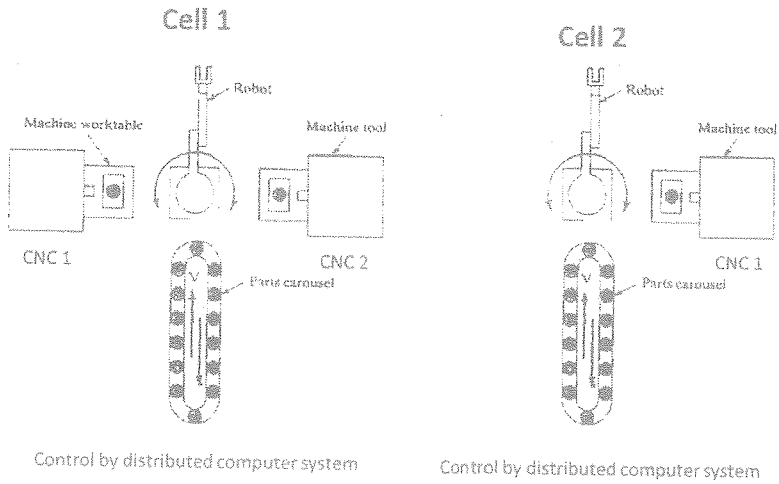

Figure Q5

d) A 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 and whose mean transport time is 3.5 min. The FMS produces three parts A, B, and C. The part mix fractions and process routings for the four parts are presented 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=$\frac{WL_i}{s_i} X\ Maximum\ production\ rate$.]

Table Q5

Part j	Part mix p_j	Operation k	Description	Station i	Process time t_{ijk}	Frequency f_{ijk}
A	0.2	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	0.3	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	0.5	1	Load	1	4	1
		2	Drill	3	23	1
		3	Inspect	4	8	0.5
		4	Unload	1	2	1

Determine :

i. Maximum production rate [3.0 Marks]

ii. Utilization of each station [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
G56	Tool length offset Z axis
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