

**UNIVERSITY OF TORONTO**  
**FACULTY OF APPLIED SCIENCE AND ENGINEERING**

**FINAL EXAMINATION, APRIL 17, 2001**  
**MIE 422S - AUTOMATED MANUFACTURING**

**Exam Type: X**

Examiner: J.K. Mills

Question	Grade
1	/25
2	/25
3	/30
4	/20
Total/100	

Name	Student Number

**Instructions to Candidates:**

**Type X Exam:**

**Materials Permitted:** lecture notes, previous tests, problem sets, solutions, labs.

**Exam Duration:** 2.5 Hours

**Attempt All Questions**

**Answer Questions in Space Provided**

**Maximum Value of Exam:** 50% of final Grade

**This exam paper has 8 pages.**

(25%) 1. An eight machine group technology work cell has the following To-From data:

From	To							
	1	2	3	4	5	6	7	8
1	0	30	45	0	0	0	0	0
2	10	0	60	0	0	0	0	0
3	50	100	0	100	0	0	10	0
4	0	0	0	0	100	50	45	30
5	0	0	0	50	0	20	50	10
6	0	0	0	40	20	0	35	50
7	0	0	0	30	20	50	0	0
8	0	0	0	0	50	40	30	0

Additional Data:      100 parts enter at machine 1  
                              200 parts exit at machine 7  
                              50 parts enter at machine 5

1(a) Construct a flow diagram for the cell. What basic function is performed by each machine, i.e. assembly...

1(b) Determine the most logical sequence of the machines according to the to-from ratios from the data presented in the table. Explain your answer fully.

1(c) Explain an alternative layout to that indicated by the to-from ratios, that would lead to a more logical cell layout. Explain your answer fully

(25%) 2. A CNC milling machine is designed to machine glass-like materials to near net shape for optical surfaces. The accuracy requirement of the machining process is to be 2-3 times the average wavelength of visible light.

The accuracy requirement (1 BLU) is  $10,000 \text{ \AA}$  or  $10^{-6}$  meters. This accuracy is required over a distance of 1 meter in each of two coordinate directions for an x-y table. A DC motor coupled to a lead screw of pitch = 4 mm., is used on each of the machine axes.

2(a) What is the maximum resolution of the encoder on each axis to achieve the specified accuracy? Note that the encoder is mounted on the output shaft of the DC motor.

2(b) How many bits are required on the encoder counter to represent a linear displacement of 1 meter, as is required by this machine?

2(c) If the “rapid traverse” velocity on each axis is 1 meter/minute, calculate the number of pulses/second sent to the DC motor.

**(30%) 3.** Design a ladder logic program for a parking garage automatic control. The operation of the parking garage is as follows:

1. The driver approaches an automated ticket machine at a gate.
2. The driver pushes a button on the ticket machine to receive a ticket. The machine does not provide a ticket if the lot is full, or the gate is up.
3. Removing the ticket raises the gate and turns on a green light.
4. After the car clears the gate, the gate lowers and the green light shuts off.
5. The vehicle population is known at any time.
6. An alarm sounds when the gate is obstructed.

**3(a)** Identify and label the inputs and outputs for this system.

**3(b)** For each distinct operation performed by the automatic parking control:

- (i) Define each action (control point)
- (ii) List the conditions that produce the desired control action
- (iii) Draw the corresponding ladder logic program rung.

3(b) Con't

**(20%) 4.** Modern CNC machines are designed so that the axes can be positioned with an accuracy of one BLU in the entire range of axis motion. An arbitrary shape is to be machined.

**4(a)** Explain, in your own words, how the motion of the CNC axes is planned so that the arbitrary shape is machined.

**4(b)** What is the difference between an analogue and a digital pulse?

4 (c) Describe what the term backlash in a machine tool means.

4 (d) How does a modern machine tool operate so that the direction of the cutter with respect to the work piece can reverse direction, without introducing machining errors, due to backlash?