PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Term Examination: Semester 2   **Academic Year:** 2009
Date: February 16, 2010   **Time:** 09:00-12:00
Subject: 226-431 Manufacturing Automation   **Room:** Robot

ทุจริตในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษา และปรับตกในรายวิชาที่ทุจริต

Directions
- There are 22 questions. The total score is 185.
- Write your own answer on your answer book(s).
- Submit all your examination sheets and answer books.
- All materials, books, calculators are allowed.

Name...Student ID..............................

Question	Full Points	Assigned Points	Question	Full Points	Assigned Points
1	5		12	5	
2	5		13	5	
3	5		14	20	
4	10		15	5	
5	10		16	5	
6	5		17	5	
7	5		18	20	
8	5		19	5	
9	10		20	5	
10	20		21	5	
11	5		22	20	

Instructor: **Mr.Suriya Jirasatitsin**

1. What is an industrial robot? (5 points)
2. What are the five joint types used in robotic arms and wrists? (5 points)
3. What is the difference between powered leadthrough and manual leadthrough in robot programming? (5 points)
4. Using the notation scheme for defining manipulator configurations, draw diagrams of the following robots: TRL. (10 points)
5. Apparatus required for a robot programming consists of two wood or plastic blocks of two difference colors that can be grasped by the robot gripper. The blocks should be placed in specific positions (call the positions A and B on either side of a center location, position C). The robot should be programmed to do the following:
   (1) Pick up the block at position A and place it at the central position C
   (2) Pick up the block at position B and place it at position A
   (3) Pick up the block at position C and place it at position B.
   (4) Repeat steps (1), (2), and (3) continually.
   Use a robot programming language to program the robot. (10 points)
6. What is a programmable logic controller? (5 points)
7. What are the advantages of using a PLC rather than conventional relays, timers, counters, and other hard-wired control components? (5 points)
8. What are the five basic components of a PLC? (5 points)
9. Construct the ladder logic diagrams for the following Boolean logic equation:
$$Y = (X1 + X2) \bullet (X3+X4)$$
   (10 points)
10. An emergency stop system is to be designed for a certain automation production machine. A single "start" button is used to turn on the power to the machine at the beginning of the day. In addition, there are three "stop" buttons located at different locations around the machine, any one of which can be pressed to immediately turn off power to the machine.
    (a) Write the truth table for this system. (5 points)
    (b) Write the Boolean logic expression for the system. (5 points)
    (c) Construct the logic network diagram for the system. (5 points)
    (d) Construct the ladder logic diagram for the system. (5 points)
11. How does material handling fit within the scope of logistic? (5 points)
12. What are the five categories of material transport equipment commonly used to move parts and material inside a facility? (5 points)
13. Name some of the different types of conveyors used in industry. (5 points)
14. A 300ft long roller conveyor, which operates at a velocity = 80 ft/min, is used to move pallets between load and unload stations. Each pallet carries 12 parts. Cycle time to load a pallet is 15 sec and one worker at the load station is able to load pallets at the rate of 4 per min. It takes 12 sec to unload at the unload station. Determine
    (a) Center-to-center distance between pallets. (5 points)
    (b) The number of pallets on the conveyor at on time. (5 points)
    (c) Hourly flow rate of parts. (5 points)
    (d) By how much must conveyor speed be increased to increase flow rate to 3000 part/hour. (5 points)
15. What is an automated guided vehicle system (AGVS)? (5 points)
16. Name three categories of automated guided vehicles. (5 points)
17. What are some of the difference between rail-guided vehicles and automated guided vehicles? (5 points)

18. An AGVS will be used to satisfy material flows indicated in the from-to chart in the table below, which shows deliveries per hour between stations (before the slash) and distances in meters between stations (after the slash). Moves indicated by "L" are trips in which the vehicle is loaded, while "E" indicates moves in which the vehicle is empty. It is assumed that availability = 0.90, traffic factor = 0.85, and efficiency = 1.0. Speed of an AGV = 1.1 m/s. If load handling time per delivery cycle = 1.0 min, determine the number of vehicles needed to satisfy the indicated deliveries per hour. NA means "Not Available". (20 points)

From	To	1	2	3	4
	1	0/0	9L/90	7L/120	5L/75
	2	5E/90	0/0	0/NA	4L/80
	3	7E/120	0/NA	0/0	0/NA
	4	9E/75	0/NA	0/NA	0/0

19. What are some of the objectives and reasons behind company decisions to automate three storage operations? (5 points)
20. Identify the three application areas of automated storage/retrieval systems. (5 points)
21. What are the four basic components of nearly all automated storage/retrieval systems? (5 points)
22. Each aisle of a six-aisle Automated Storage/Retrieval System is to contain 50 storage compartments in the length direction and 8 compartments in the vertical direction. All storage compartments will be the same size to accommodate standard size pallets of dimensions: $x = 36$ inches and $y = 48$ inches. The height of a unit load $z = 30$ inches. Using the allowances $a = 6$ inches, $b = 8$ inches, and $c = 10$ inches, determine

      (a) How many unit loads can be stored in the AS/RS? (10 points)

      (b) The width, length, and height of the AS/RS. The rack structure will be built 18 inches above floor level. (10 points)