

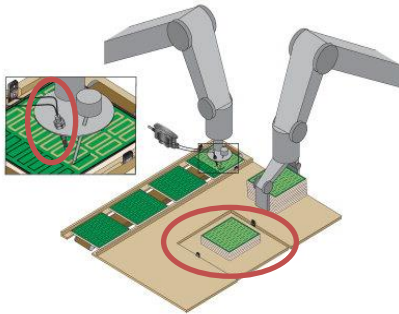
University of Cincinnati
College of Engineering & Applied Science
MECH6031/5131 Intro to Robotics
Test#2 Robot Spec, Sensors, End Effectors, Actuators
(100 pts for UG, 125 for G)

STUDENT NAME: _____

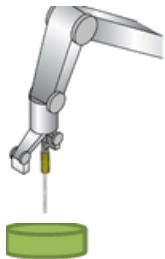
SCORE: _____

Part I: Briefly answering the following questions. (xxx)

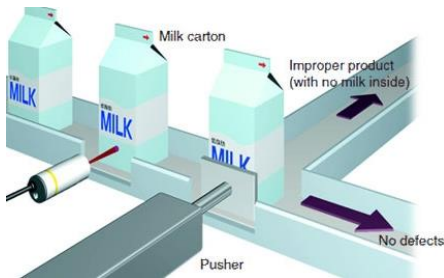
1. (6 pts) Choose suitable sensors for the following application.
- (a) sensor (positioned near where the robot applies the adhesive and can be adjusted for different adhesive layouts) to verify that adhesive is applied to the IC wafer
 - (b) sensor to detect the level of filled wafer trays (so when tray reaches preset level, robot arm will take it away)
- Explain the reasons for your choices in a) and b).



2. (3 pts) Select a sensor type to detect the distance from the end of the robotic arm to the surface of the part and justify your selection.



3. (5 pts) Choose a sensor to detect if there is milk inside the carton. Justify your answer.



4. (a) (4 pts) Explain the differences between inductive sensors and capacitive sensors. Give at least two differences.
- (b) (3 pts) Give an application example that an inductive sensor can be used. Use sketches.
- (c) (3 pts) Give an application example that a capacitive sensor can be used. Use sketches.
5. (6 pts) What are the major differences between photoelectric reflective sensors and pyroelectric infrared sensors?
6. (6 pts) Why are capacitive sensors sensitive to temperature and humidity? What are the main advantages of capacitive sensors?

7. (6 pts) What are the main advantages of using Radar sensors over ultrasonic sensors?
8. (6 pts) For a given joint in a robot, what is the accuracy? What determines its accuracy?
9. (8 pts) In a machine loading and unloading application,
 - (a) (2 pts) What are the advantages of a dual gripper design over a single gripper design?
 - (b) (3 pts) Describe the similarities of the design and motion of these abovementioned in (a) two kinds of grippers.
 - (c) (3 pts) Describe the differences of the design and motion of these abovementioned in (a) two kinds of grippers.
10. (5 pts) Describe harmonic drive and give an application example of using harmonic drive.
11. (5 pts) What is an actuator? Briefly describe how to select an actuator for a given joint or end effector.
12. (8 pts) Design a robot gripper or gripper mechanism to pick and place wine glasses as shown below. Describe how it works. And what factors do you consider in designing such gripper? Please use sketches to illustrate your gripper design.



13. (5 pts) What is compliance tooling? Use sketch to explain why we use it for assembly applications?
14. (7 pts) What is Tool Center Point (TCP)? Why knowing such point is critical in robot applications? Use two sketches to illustrate the TCP for a welding gun and for a two-finger gripper.
15. (9 pts)
 - (a) What is cycle time of a robot application?
 - (b) Give at least three factors that affect the cycle time?
16. (6 pts) For an application of using robot to assemble laptop circuit boards, what are the top three robot selection criteria you would use? Explain why.
17. (6 pts) During the process of selecting or designing grippers for a given application, why is knowing the part or object crucial or what factors do you consider on the part or object to help you make gripper selection/designing decisions? Explain. Use sketches if necessary.
18. (4 pts) What type of motors will be a good choice for a base joint in an articulated robot? Explain.
19. (9 pts) Use sketches to illustrate three ways or three methods to actuate a gripper for an open and close actions.
20. (a) (3 pts) What are the applications of using three finger grippers? Use sketches.
 (b) (3 pts) What are the applications of using four finger grippers? Use sketches.

Part II. Calculation problems. (xxx pts)

21. (10 pts) The vacuum plate below picks up a layer of carton boxes that weight 50 pound. If the vacuum is 0.70 bars behind the gripping surface, how many 1/2-inch holes will be required to lift the boxes?



22. (8 pts)

Determine the diameter of vacuum cups (*six*) for lifting window glass that weighs 20 pounds. Assume a vacuum of .70 atmospheres.

23. (10 pts) A parallel gripper is used to keep a 30 pound part from slipping when the robot tooling accelerates upward and at a rate of 8 feet per second squared. The coefficient of static friction is 0.70.

(a) (4 pts) Draw FBD or Kinetic diagram to show gripper holding the part.

(b) (4 pts) Determine the friction force needed for the gripper design.

(c) (2 pts) Determine the minimal normal force required for the gripper.

24. (12 pts) A robot loads and unloads a CNC turning machine from a central conveyor. The following average robot operation times apply:

Pick up part from conveyor (including average wait time in pickup position)-----3.0 sec

Move robot hand from conveyor to machine -----1.7 sec

Load part into machine and back hand away from machine so the machine can start ----1.1 sec

Unload part from machine -----0.8 sec

Move robot hand from machine to conveyor -----1.7 sec

Deposit part onto conveyor -----0.5 sec

Suppose the turning machine operations cycle requires 8 seconds, and 100% efficiency,

(a) (3 pts) What is the cycle time if a single gripper is used? Calculate the production rate per hour.

(b) (5 pts) What is the cycle time if a dual-handed gripper is used, and why? Calculate production rate per hour.

(c) (4 pts) How much improvement of production rate from a dual gripper design over a single gripper design? Do you recommend using single gripper design or dual gripper design for this application? Why?