

National Exams May 2016

04-Bio-B7, Robotics and Manufacturing Automation

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an CLOSED BOOK EXAM.
One aid sheet allowed, written on both sides.
Approved Casio or Sharp calculator is permitted.
3. FIVE (5) questions constitute a complete exam paper.
The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Some of the questions require an answer in essay format. Clarity and organization of the answer are important.

Question 1

- a) A K-type thermocouple is measured to give a voltage of $82\mu\text{V}$ at 20° , and a 32.6 mV at 800°C . A linear output/input relationship exists for this temperature range. Determine the transfer function of the thermocouple.
- b) For the above thermocouple, determine the voltage at 100°C .
- c) Repeated measurements were taken using the above thermocouple of the same 100°C . Explain the difference between accuracy and precision of the measurements.
- d) Other than a thermocouple, what other sensor can be used to measure temperature?

Question 2

A PLC is used to sequence an automatic drilling operation. A worker manually clamps the raw stock piece into the drill press fixture, initiates the operations by pressing the start button and also unloads the finished part after the drilling operation is done (as indicated by a light). The drilling operation consists of: turning on the spindle, turning on the coolant, feeding down the drill bit to a preset depth (as determined by the bottom limit switch), then retracting the drill bit (until the top limit switch is activated) and turning off the spindle and coolant.

- a) Specify the variables for the system (eg. X1, X2, C1, etc.)
- b) Construct a ladder logic diagram for the system.

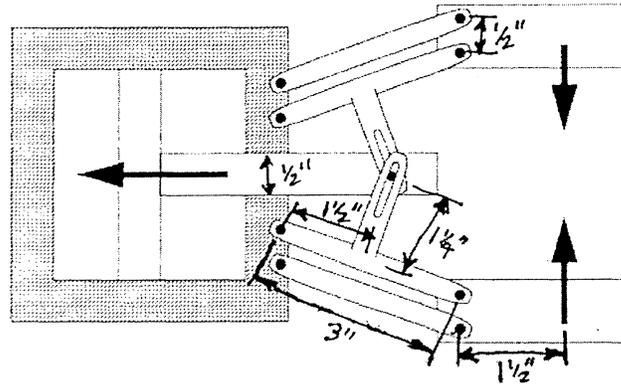
Question 3

Name the 5 types of robot configurations commonly available in industrial robots. For each of the 5 configurations:

- a) name the types of joints
- b) the degrees of freedom (DOF) of the robot
- c) sketch of the robot, with each joint identified.

Question 4

The robot end-effector below is required to grip with a 10lbf. If the pneumatic cylinder is supplied at 100psi, calculate the diameter of the cylinder.

Question 5

A machine vision system is used above a conveyor belt to inspect a sheet metal stamped part. If the camera sensor is 100cm above the conveyor, is installed with a 15mm lens and has a 640 x 480 pixel array on a 6mm x 4.5 mm sensor.

- What is the minimal measurement that the camera can obtain on the sheet metal parts below?
- What is the field of view (x & y)?
- Sketch a diagram of the machine vision system referred to in the question, labeling the important parts required for a successful machine vision application.

Question 6

A Geneva mechanism is used to turn a worktable of a dial indexing machine. If the machine has 8 stations, and the slowest station requires 4.3 sec, calculate:

- The indexing time for each cycle.
- The rotational speed of the driven member of the Geneva mechanism.
- If the frequency of stops is 0.075 stops per cycle, and the average downtime is 5 mins., what is the average production rate in pieces/hour?
- The line efficiency?
- Proportion of downtime?