Chapter 7 Review Questions Answer Key

1. If you have a limit switch in the field that has the actuator in the wrong position and a removeable head unit, how would you correct this situation?

   A: By removing the appropriate screws and then turning the actuator as need.

2. What do you need to know when selecting a limit switch?

   A: When selecting a limit switch you will need to know how much amperage the contacts must handle, how fast the switch needs to respond, and how much force the object contacting the limit switch will generate.

3. What are some of the disadvantages of solid-state devices?

   A: Most solid-state devices never fully stop the flow of electrons, though often it is only a very small amount that leaks through. They are also vulnerable to electromagnetic pulses (EMP) and other strong magnetic fields.

4. What is the sensing range for inductive proximity switches from low power to high power?

   A: Proximity switches with a low strength magnetic field can sense items at a maximum distance of 0.06 in. or 1.5mm while the stronger inductive proximity switches can sense metal items up to 1.6 in. or 40 mm away.

5. Describe the operation of an inductive prox switch.

   A: When a metal part enters the magnetic field of the inductive prox, it generates eddy currents in the part and this takes energy away from the magnetic field created by the oscillator in the prox. The eddy currents and their induced magnetic fields draw enough power from the oscillator that eventually it can no longer create an oscillating field. A separate unit in the prox known as the trigger unit looks for the oscillation to die down to a certain level and it then activates the output(s) of the prox accordingly.

6. Describe the operation of a capacitive prox switch.

   A: The capacitive prox works just the opposite of the inductive prox in that the oscillation of the circuit *begins* when the item sensed enters the electrostatic field and it dies off when no object is present. The capacitive prox has an adjustment on the switch that allows the user to vary the electrostatic field and change the distance it interacts with objects.

7. What is the typical sequence for photoelectric switch operation?

   A: 1. An oscillator module turns on the transmitter, usually an infrared LED, on and off at high speeds.

   2. The light travels out and either travels in a straight line to the receiver or is reflected by some surface.
   3. The receiver, when the correct light strikes it, will transmit signals into the internal components of the switch.
   4. If a threshold is met the switch will change the state of contacts or pass along information to another process. This threshold value is adjustable in many sensors and this adjustment is crucial for small, fast moving parts.
   5. If the wrong frequency/type of light enters the receiver or not enough of the transmitted light makes it to the receiver, the switch does not change conditions or only passes on partial information.

8. Briefly describe how through-beam, retroreflective, and diffuse photoelectric switches operate.

   A: Through-beam photoelectric sensors separate the transmitter and receiver into two separate units, placed opposite one another. In this configuration the common application is to set up the system to change state when the signal is broken, indicating something is blocking the light. Retroreflective photoelectric sensors have the transmitter and receiver in one assembly and often use something like a bicycle reflector to return the emitted light back to the receiver. Diffuse photoelectric sensors also house both transmitter and receiver in one housing, but in this case only a small amount of returned light is needed to activate the sensor. Instead of a reflector, the part is what returns the light and thus this system tends to change state when the part is present and enough light reaches the sensor.

9. What can we use light level photoelectric prox switches to detect?

   A: With the light level detection photoelectric switch we can tune out or ignore the background, differentiate between parts on a background, and even detect transparent objects.

10. How does a Hall effect sensor work?

    A: When current flows through a conductor in a magnetic field, the magnetic field tends to push the negatively charged atoms to one side of the conductor and the positively charged atoms to the opposite side, when the magnetic field is perpendicular or at 90° to the conductor.

11. Which types of information are we looking for with tactile sensors?

    A: Tactile sensing is about determining how much force is applied, what is the shape of the part, how do we have it gripped, is the part hot or cold, basically the same kinds of sensing tasks that skin performs for the human body.

12. Which types of information are we looking for with impact sensors?

    A: Impact sensing is concerned with detection of collisions, determining if forward movement is impeded or stopped, and perhaps most importantly, shutting down or modifying the motion of the system to prevent damage to both whatever is hit and the robot.

13. Which information can we gain from a tactile array that senses 1 or 0?

    A: With this type of sensor the system knows if it is gripping the part or not and how many elements are involved with that grip, which is enough to find edges and determine if the part is moving in the gripper during travel by monitoring for changes in element state.

14. Which kinds of information can a high-end complex tactile sensor provide to a robot?

    A: High-end complex tactile sensors can provide information about the shape of the object, the amount or pressure applied, temperature, finish, and other analog type sensing that is difficult if not nearly impossible with digital signals.

15. How do we commonly monitor impact today?

    A: Today we commonly either monitor the amperage the motor uses or insert sensing devices designed to detect impacts. The common sensing devices are strain gauges and the like at crucial points, such as the joints of the robot, to detect sudden changes in the forces of motion so the robot can respond accordingly.

16. What are some things other than an impact that could trigger an alarm when we use current monitoring for impact?

    A: Anything that causes the motor to use excessive amounts of current such as too heavy of a load, bad bearings, friction, caked dirt in the joints, etc. can cause an impact alarm.

17. What is the benefit of disengaging the axes as opposed to the E-stop method of stopping the robot when impact is detected?

    A: It reduces the force the robot has to stop, reduces the energy of the impact, and reduces the stress on the robot's internal systems.

18. What are the differences between thermocouples, RTDs, and thermistors?

    A: Thermocouples are temperature sensors that work off the principle of a small DC millivoltage generated when the junction of two dissimilar metals is heated. Resistance temperature detectors (RTDs) work on the principle of a linear increase in resistance when a metal is exposed to heat. Thermistors are resistors that have a consistent change in resistance with a change in temperature.

19. What are the differences between turbine, target, and magnetic flowmeters?

    A: Turbine flowmeters use a propeller or turbine type assembly placed inside the fluid to generate a signal via a magnetic pickup sensor positioned nearby, but outside of the fluid. Target flowmeters place a disk or similar shape in the fluid and use the force of the fluid flow to deflect the target and generate a signal.

Magnetic flowmeters, also known as induction flowmeters, measure the change in voltage induced into the passing fluid.

20. Describe the typical operation of a three-probe capacitive level sensor.

    A: With three or more probes, there is one probe longer than the rest, that is the main electrostatic source. The next longest probe would be the low-level probe and as soon as the liquid makes contact with this probe, current flows in the sensor. If this is the only probe active in the sensor or none of the probes are active, then the system knows the fluid is low. With three probes, the next probe is the shortest of the three: the high-level probe. When current flows through this probe the system knows the fluid has reached the high level and it is time to stop the flow.

21. What is the difference between a plunger and a Bourdon tube pressure gauge?

    A: Plunger pressure gauges use a plunger that is exposed to system pressure, a bias spring, pointer, and a calibrated scale to measure pressure. Bourdon tube pressure gauges use a thin walled, slightly elliptical cross-sectioned tube bent in a C shape tied directly to the system to read pressure.

22. What is the difference between an open loop control system and a closed loop control system?

    A: Open loop systems work on the assumption that the control pulse, whatever it may be, activates the motion system and the robot performs as expected. Closed loop systems send out the control pulse, whatever it may be, to initiate movement and then receive back a signal that confirms movement and in many cases which direction and how far.

23. What are the parts of the optical encoder? How does this device work?

    A: Optical encoders consist of a disk that has either holes for light to pass through or special reflectors to return light, an emitter, a receiver, and some solid state devices for signal transmission and such. The principle of operation is simple, the transmitter sends out light and the light either passes through the holes or reflects back to the receiver, triggering the electronics of the encoder to send a signal back to the controller.

24. How can we determine the direction of rotation with incremental encoders?

    A: By adding a second row of reflectors or light windows, we can now determine the direction of rotation by comparing the signals from the two rings as each direction of rotation will generate a specific signal when comparing the two.

25. How does an absolute encoder work?

    A: Absolute optical encoders add enough emitters and receivers, usually four or more in total, to give each position of the encoder its own unique binary address.

26. How do ultrasonic sensors work? How do we determine the distance from the sensor to the object detected?

    A: An ultrasonic sensor consists of a transceiver, a comparator, a detector, and an output device. The transceiver sends and receives the ultrasonic signal and because it is both a sender and a receiver it has a "dead" zone located within a few millimeters of the transducer. The comparator/detector calculates the distance from the front of the sensor by measuring the return time of the pulse and comparing it to the known velocity of sound.

27. What is the difference between a sourcing signal and a sinking signal?

    A: A sourcing signal input provides the positive connection or DC voltage (usually 24 volts) to the input module. A sinking signal input provides the negative connection or ground to the input module.

28. What is optical isolation?

    A: Optical isolation works by creating a dead zone where the only connection between internal electronics and outside connections is light.

29. What are the three main things to verify when making a sensor connection to the robot?

    A: 1. Make sure it is the right type of voltage: AC or DC.

    2. Make sure it is the right level of voltage as too much can cause damage and too little will likely not trigger the input or run the output.
    3. Make sure it is the right type, as digital is on or off and analog is a range. When it’s analog make sure it is the right type of signal for the card it is tied to and the device it works with.

30. What are the six main criteria for selecting a sensor?

    A: 1. What you are measuring

    2. Operating environment
    3. Failsafe requirements
    4. Accuracy
    5. Type of output
    6. Cost versus performance