Closed book, closed notes. Answer the “word” questions on the test pages in the space provided.


2) [3] What is the name of the component represented by the schematic symbol given below and what is it typically used for?

4) [3] What are three types of non-contact proximity sensors other than photoelectric?

5) [6] Sketch the schematic symbol for each of the following:

- Three position, four way, closed center, solenoid activated, spring return solenoid valve
- Reversible hydraulic pump
- Pressure regulator

6. [3] Name and/or sketch the three common configurations for photoelectric proximity sensors.
7) [20] A factory automation system is shown below. Fully describe the correct operation of this system on a rung-by-rung basis.
8) In the space provided below, sketch complete fluid power systems with the following capabilities. Include and label all necessary components for safe, effective operation – not just the cylinders and valves mentioned.

**Hydraulic:** two hydraulic cylinders (which cannot be powered simultaneously) controlled by three position, solenoid activated, spring return directional control valves

**Pneumatic:** one pneumatic cylinder with flow control valves for speed control and a two position, palm activated, spring return directional control valve
9) A local manufacturer has a need for a pneumatic system controlled by a PLC. The system employs three double acting, single ended cylinders controlled by 2 position, 4 port, solenoid actuated, spring return, directional control valves as shown in the figure below. The desired task is:

- A momentary contact pushbutton (wired NO, connected to X0) is pressed when a part is ready to be processed.
- Cylinder A extends and pushes a part into the clamp fixture (not shown), and remains extended.
- Cylinder B then extends and “drills” the part the first time, then retracts.
- After Cylinder B has fully retracted, Cylinder C then extends fully, waits 2 seconds, then retracts.
- After Cylinder C retracts, Cylinder B then extends and “drills” the part the second time, then retracts.
- The part is then unclamped by retracting Cylinder A, and the part is removed from the clamp fixture by another automation system.
- Your system returns to the original start-up configuration when Cylinder A is fully retracted.

Your problem:

a) Draw a PLC wiring diagram for the limit switches and solenoids.

b) Design a PLC type ladder logic diagram to control the system. Be sure to provide a brief description beside each rung of the ladder to describe what you are trying to accomplish.