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?

![Schematic Symbol]

4) [6] Give the major advantage and major disadvantage of each type of proximity sensor in the table below.

<table>
<thead>
<tr>
<th>Type</th>
<th>Major Advantage</th>
<th>Major Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inductive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photoelectric</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical “microswitch”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

- Two position, three way, solenoid activated, spring return solenoid valve
- Variable displacement compressor
- Fixed restriction
6) [20] A factory automation system is shown below. An inductive proximity sensor (wired to input X3) detects the presence of metallic objects (shown in the dashed lines) as they move down the conveyor.

Fully describe the correct operation of this system on a rung-by-rung basis.
A fluid power system and its controls are shown below. The circuit is intended to operate as follows:
1) operator presses two pushbuttons (X12 and X13) to start system in operation,
2) cylinder A completely extends, waits 5 seconds, then fully retracts,
3) once cylinder A is fully extended, cylinder B then completely extends and immediately retracts 6 times,
4) if the pushbutton wired to X18 is pressed at any time, the cylinders both retract and the circuit returns to the start-up configuration.

Unfortunately, the PLC circuit below does not accomplish the task.

a) Describe FOUR major flaws in the design given below that prevent the system from operating properly.

b) Draw a new circuit diagram that corrects the problems. Note that NO NEW PNEUMATIC COMPONENTS can be used!
8) [40] 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.
- Cylinder B remains in the extended position for 2.5 seconds, then retracts.
- After Cylinder B has fully retracted, Cylinder C then extends, rotates the part (and clamp fixture) 90 degrees, then retracts.
- After Cylinder C retracts, the part is 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.