The entire test is closed book, closed notes. You will get problems 5, 6, and 7 after you turn in this page.

1. [10] Identify each of the pneumatic system components on the diagram below with a complete name/description.

2. [5] Several rules for creating ladder logic diagrams were given in your notes and were discussed in class. Based on these rules, sketch an illegal “OR” block in a PLC diagram and describe why it is not allowed.
3. Name 3 of the 4 fundamentally different sensing technologies/types of proximity sensors studied in ME 360 and used in lab. Give a primary advantage of each technology/type over the others.

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<th>Technology</th>
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4. Show the connections necessary to wire an OMRON proximity sensor to input X3 of the Direct Logic 05 PLC shown below. The schematic label attached to the proximity sensor is shown to the left (do NOT wire the schematic to the PLC!)

![Proximity Sensor Schematic](image)

![Direct Logic 05 Schematic](image)
5. [15] A pneumatic system and its PLC controls are shown below. Completely describe the operation of the system in the space provided below the figures.
6. [20] A pneumatic “palletizing” system is shown on the right. The circuit is intended to operate as follows:

- operator presses Start pushbutton
- if the stack cylinder is retracted, rolls drop out of the hopper and activate limit switch X5,
- if the palletize cylinder is retracted, the stack cylinder pushes the roll off of limit switch X5 and onto the pallet, then the stack cylinder retracts,
- the next roll drops out of the hopper once the stack cylinder fully retracts,
- once three rolls are pushed onto the pallet and the stack cylinder is retracted, the palletize cylinder extends and pushes the rolls to the next stage of the process, then the palletize cylinder retracts,
- the cycle continues (as long as rolls are available) until the Stop button is pressed.

Unfortunately, the PLC circuit does not accomplish the task.

- Describe THREE major flaws in the design given below.
- Provide a new circuit diagram that corrects the problems. Note that NO new limit switches can be used!

Note that you will NOT have a “debugging” problem like this in your exam in Spring ‘03.
7. [40] Design a PLC ladder logic diagram to accomplish the task described below. Give a written description of each rung of your diagram explaining what you are trying to accomplish.

In the system shown, two pneumatic cylinders are used to push parts into the “short” and “tall” part hoppers. Parts are automatically fed to the conveyor belt by another automated system.

- After X10 is pressed the operation begins and continues until X11 is pressed.
- The position of each cylinder is detected by the externally mounted proximity sensors X1 to X4.
- The “short part” through-beam photo sensor (X5) activates when a “short” part breaks the beam (dotted line). A part is in position to be ejected into the hopper when the front edge breaks the beam.
- The “short part” sensor may or may not remain activated while the part is pushed off the conveyor.
- The “tall part” photo sensor (X6) works similarly to the “short part” sensor.
- Y0 is activated and the motor moves the conveyor belt to the left one second after a cylinder retracts.
- Output Y3 is activated for 2 seconds to “dump” the hopper after 50 of the “short” parts have been pushed. The conveyor belt motor must be stopped while Y3 is activated.
- No action is required for the “tall part” hopper.