| Faculty: | | FACULTY OF ELECTRICAL ENGINEERING | | |
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# SKEE/SKEM/SKEL 3742

## FACULTY OF ELECTRICAL ENGINEERING
## UNIVERSITI TEKNOLOGI MALAYSIA
## SKUDAI CAMPUS
## JOHOR

# APPLIED CONTROL LABORATORY
## STUDENT PACK

**Introduction to PLC and Design (Using GLOFA GM6 PLC)**
**Factory Automation System (ED-4031) – Task 1**

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| Signature | : | Signature | : |
| Stamp | : | Stamp | : |
| Date | : 1 February 2018 | Date | : 1 February 2018 |

| 1. | **Problem/Project Guide:** |
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Programmable Logic Controller (PLC) is a highly autonomic program controller that replaces the existing relay, timer and counter functions with semiconductor elements. It is like integrated circuit (IC) and transistor with a numeric operation function to basic sequence control function. According to the National Electrical Manufacturers Associations (NEMA), PLC defined as "digitally working electronic device that uses a programmable memory and controls various machines or processors to execute special functions like logic, sequencing, timing, counting and operation through digital or analog input/output module". In other words, PLC can be configured as an automation system that performs an advanced control with various functions.

Prior to PLC, there are other similar devices that could configure the automation system based on mechanical logics like hydraulic/pneumatic, electric relay sequence or hard-wired electronic logic circuit. Those devices include an organic correlation between basic three control elements in a limited space and they play their own roles respectively as follows:

1. Input: Represented by sensor, it converts physical signals into electric signal and send it to control element

2. Control: Receive information from sensor, judge it according to command conditions in a pre-set program and send the processing results to the output element.

3. Output: Drive actual movement according to control signals displayed from control element by using actuator.

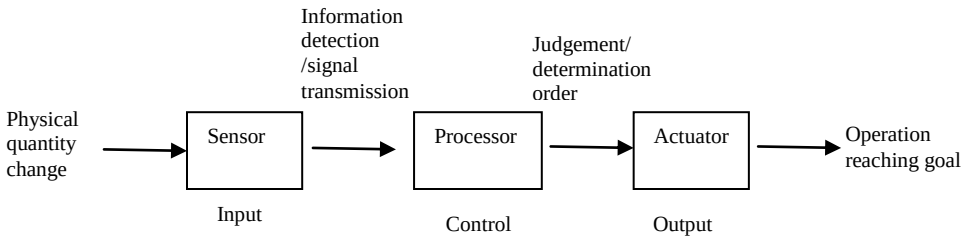


**Figure 1**: The correlations of the elements in the system

As it is easily programmable to accomplish a variety of control operations, it quickly gains wider applications in industry by replacing its predecessor, the electromechanical relays. The relays are now commonly used as switches and no longer as logical controllers. Logical systems are normally represented graphically by using state diagrams or other similar methodologies. The representation is then transformed to ladder logic diagrams and implemented in PLC by using its programming language which resembles the ladder logic diagram.

The purpose of this project is to control a **factory automation system** by using a PLC approach. The system includes all the basic processes for production automation such as transfer, processing, inspection, classification and storage.

**a) Problem Objectives:**

- To design factory automation control system using GLOFA GM6 PLC and ED-4031 trainer.
- To demonstrate the proposed control sequence by using ladder diagram in GMWIN software.

**b) Problem Design:**

The PLC controller at your production line (which represented by ED-4031 system) is changed to the new one. The sequential process is now controlled by GLOFA GM6 PLC system.

Your team is assigned to look into this problem and come out with a good solution to make sure the production line can be operated as normal without any problem. The report for the solution needs to include the sequence of operation for each check point in the production line system.

To tackle the problem design, students are required to perform the task in c section.

**c) Task :**

You need to perform the task under the following conditions. Please make sure the basic wiring is connected to the system in accordance with the input & output wiring diagram, and write a PLC program to control the system, and carry out its trial run.

1) **Supply**: Insert objects (all metal/nonmetal objects) into the magazine according to the conveyor system, as in Figure 2. Press the Start Push button, the part sensor will detect the WORK. Then move forward the supply cylinder to supply the WORK. After that move backward the supply cylinder by forward completion signal. (Note: You also can used the object with hole to be considered as defected)
2) **Processing**: Press the Start Push button to move forward the drill working cylinder, process the WORK for five (5) seconds and move backward the drill working cylinder.
3) **Defective Extraction**: Press the Start Push button to activate the conveyor belt and place the WORK on the conveyor manually. If the WORK is judged as defective through the defective sensor, move forward the extraction cylinder in three (3) seconds to extract the WORK.
4) **Metal Extraction**: Press the Start Push button to activate the conveyor belt and place the WORK on the conveyor manually. If the WORK is judged as defective through the metal sensor, move forward the extraction cylinder in three (3) seconds to extract the WORK.
5) **Supply & Processing**: Press the Start Push button, if the part sensor detects the WORK, move forward the supply cylinder to supply the WORK and move forward the drill working cylinder to process the WORK for three (3) seconds. Then move the backward the drill working cylinder to complete the processing and move backward the supply cylinder to prepare transfer.
6) **Transfer & Extraction**: Press the Start Push button to operate the conveyor belt first. Then move forward the transfer cylinder to transfer the WORK to the conveyor belt. Move backward the transfer cylinder and extract the WORK with the extraction cylinder in five(5) seconds.
7) **Transfer, Inspection & Extraction Task 1**: Press the Start Push button to activate the conveyor belt first. Then move forward the transfer cylinder to transfer the WORK to the conveyor belt. Move backward the transfer cylinder and inspect the processing status by using the defective sensor. If it is judge as defective, move forward the extraction cylinder in three (3) seconds to extract the WORK.
8) **Transfer, Inspection & Extraction Task 2**: Press the Start Push button to activate the conveyor belt first. Then move forward the transfer cylinder to transfer the WORK to the conveyor belt. Then move backward the transfer cylinder and inspect whether there is metal or nonmetal by using the metal sensor. If it is judge the metal, move forward the extraction cylinder in three (3) seconds to extract the WORK. If it is judged as non-metal, save the WORK into the good parts storage.
9) **Supply, Processing, Transfer, Inspection & Extraction (Complete production line setup):** Press the Start Push button to activate the conveyor belt first. If the part sensor detects the WORK, move forward the supply cylinder to supply the WORK and move forward the drill working cylinder to process the WORK for five (5) seconds. Move backward the drill working cylinder to complete the processing. Then, move backward the supply cylinder and move forward the transfer cylinder to transfer the WORK to the conveyor belt and move backward the transfer cylinder. Inspect the transfer WORK by using the defective sensor/metal sensor. If it is judge as defective, move forward the extraction cylinder in three (3) seconds to extract the WORK and stop the conveyor. If it is judged as a nondefective, store the WORK into the good part storage and stop the conveyor in ten (10) seconds.

**Note:** Please use the basic I/O allocation set to ED-4031 in Table 1. You may use suitable sensor S2 for defective object detection.

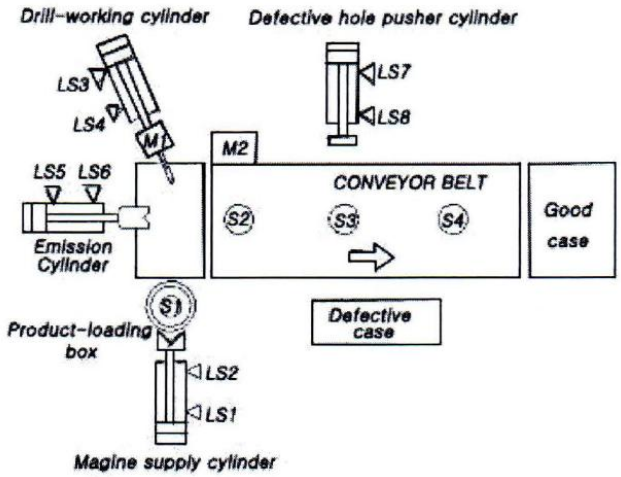


**Figure 2:** Conveyor system configuration diagram

A report supported with the experiment result is expected to be produced at the end of the task. The collected data and analysis should be well presented and discussed in detail in the report.

**d) Problem-solving Time-line**

| Activities | Week 1 | Week 2 | Week 3 |
|---|---|---|---|
| **1. Briefing, PLC exercises, brainstorming, oral interview, submission of proposal** | | | |
| **2. Design/programming/experiments, oral interview, individual report** | | | |
| **3. Analysis, oral interview, demonstration of final designed** | | | |

**e) Proposal write-up**

You are expected to submit a handwritten project proposal on one page of paper + attachments (e.g. a flowchart for software based project). Each write-up is to be submitted as teamwork on the **first week** of the laboratory. Please ensure that each team member is responsible enough to contribute in completing the work. Your proposal may include the following information:

- title
- objective
- problem statement
- methodology (flow chart/block diagram/list of equipment, materials)
- expected outcome

**f) Report writing**

A group report needs to be submitted in the **post week** after the third week of laboratory session. Your report should follow the general guide by the Laboratory Coordinator such as abstract, introduction, methodologies etc.

Other than the general guide, your report for this laboratory may also include:

- Review and circuit diagrams
- Data and graph as a results
- Photographs of the actual circuit construction
- Photographs of your group members

**g) Questions That Can Help You Tackle The Problem**

1) How does Factory Automation Trainer work?
2) What are the inputs and outputs of the system?

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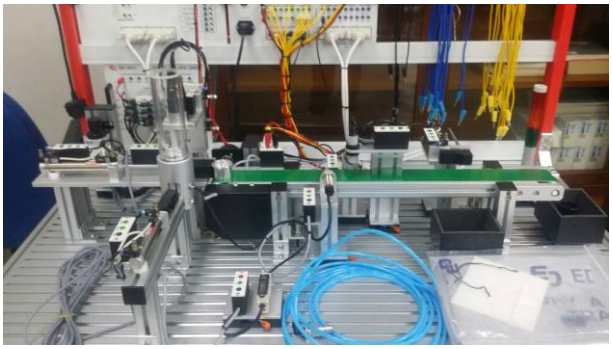
| | 3) How does the solenoid valve operated?<br>4) What is:<br>a. Timer<br>b. Counter<br>c. Single/ double acting cylinder<br>d. holding circuit<br>e. limit switch<br>f. capacitive/ inductive sensor<br>5) How do you define the accuracy of the design? |
| **2.** | **Equipment list:** |
| | (a) Factory Automation Trainer System ED-4031<br>(b) GLOFA GM6 PLC |
| **3.** | **Components list:** |
| | (a) Connector<br>(b) Jumper wire, wire<br>(c) Pneumatic air tubes |
| **4.** | **Software:** |
| | (a) PLC programming software: GMWIN Programmer |
| **5** | **Additional resources:** |
| | Materials related to the problem/project. Can be technical papers, short manual on how to use GMWIN programmer software or other software for a particular problem/project, links to websites etc. Examples as follows:<br>(a) GLOFA, 2001, "User Manual XG5000".<br>(b) Factory Automation Trainer System ED-4031 – User manual<br>(c) Exercises of SMC pneumatic<br>(d) Please refer to page 2-24 (A Beginner's Guide to PLC) to get examples of PLC electrical wiring.<br>(e) Figures of the Factory Automation Trainer System ED-4031 as follows:<br>  <br>Factory Automation Trainer System ED-4031<br>  <br>Conveyor System of ED-4031 |

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|---|---|
| |  <br>ED-4031 Panel Indicator (Unused)<br>  <br>ED-4031 PLC Trainer Unit<br>(Unused I/O terminal as marked) |
| **6.** | **References:** |
| | |

**Appendices**

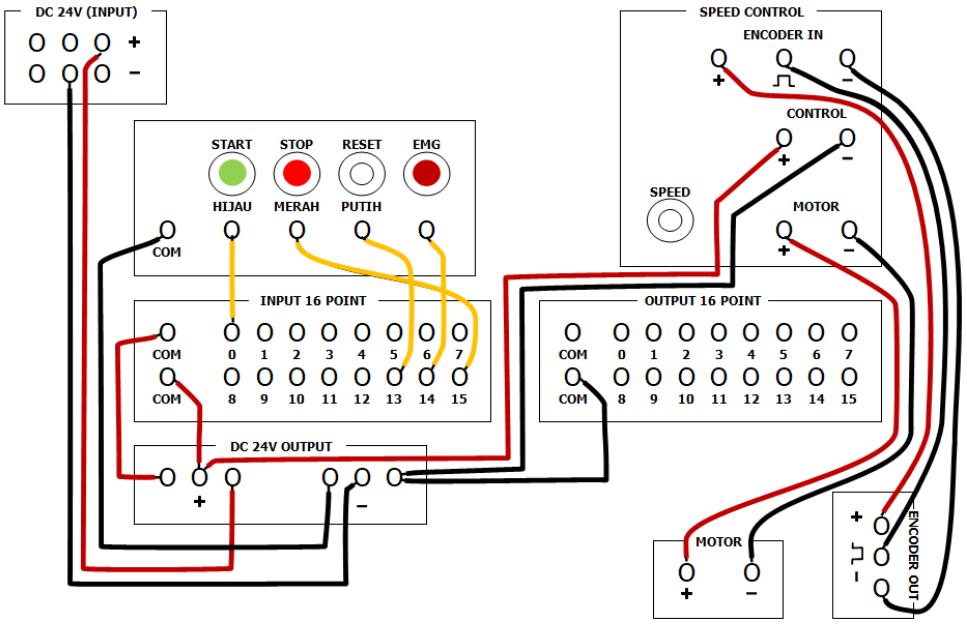


**Figure 3:** Basic wiring for ED-4031

**Table 1:** Basic I/O allocation set to the ED-4031

| INPUT | | | OUTPUT | | |
|---|---|---|---|---|---|
| %IX0.0.0 | PB1 | Start S/W | %QX0.1.0 | | |
| %IX0.0.1 | LS1 | Product supply cylinder backward | %QX0.1.1 | Y1 | Product supply cylinder forward |
| %IX0.0.2 | LS2 | Product supply cylinder forward | %QX0.1.2 | Y2 | Product supply cylinder backward |
| %IX0.0.3 | LS3 | Drill working supply cylinder backward | %QX0.1.3 | Y3 | Drill working supply cylinder forward |
| %IX0.0.4 | LS4 | Drill working supply cylinder forward | %QX0.1.4 | Y4 | Product transfer cylinder forward |
| %IX0.0.5 | LS5 | Product transfer cylinder backward | %QX0.1.5 | Y5 | Defective extraction cylinder forward |
| %IX0.0.6 | LS6 | Product transfer cylinder forward | %QX0.1.6 | M2 | Conveyor Belt foward |
| %IX0.0.7 | LS7 | Defective extraction cylinder backward | %QX0.1.7 | | |
| %IX0.0.8 | LS8 | Defective extraction cylinder forward | %QX0.1.8 | Y6 | Defective extraction cylinder 2 forward |
| %IX0.0.9 | S1 | Part Sensor | %QX0.1.9 | M1 | Drill Rotation motor |
| %IX0.0.10 | S2 | Defective Sensor | %QX0.1.10 | L1 | Warning Light 1(green) |
| %IX0.0.11 | S3 | Material Arrival Sensor | %QX0.1.11 | L2 | Warning Light 2(yellow) |
| %IX0.0.12 | S4 | Metal Sensor | %QX0.1.12 | L3 | Warning Light 3(red) |
| %IX0.0.13 | LS9 | Defective extraction cylinder 2 backward | %QX0.1.13 | | |
| %IX0.0.14 | LS10 | Defective extraction cylinder 2 forward | %QX0.1.14 | | |
| %IX0.0.15 | PB2 | Stop S/W | %QX0.1.15 | | |