UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF INDUSTRIAL TECHNOLOGY

FINAL EXAMINATION

JANUARY 2016 SEMESTER

COURSE CODE	:	JCB 30103
COURSE TITLE	:	PROGRAMMABLE LOGIC CONTROL
PROGRAMME LEVEL	:	BACHELOR
DATE	:	25 MAY 2016
TIME	:	9.00 AM – 12.00 PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consists of TWO (2) sections.
4. Answer ALL questions in Section A. Choose ONE (1) questions in section B.
5. Please write your answers on the answer booklet provided.
6. Please answer all questions in English only.

THERE ARE 12 PAGES OF QUESTIONS EXCLUDING THIS PAGE.

SECTION A (TOTAL: 50 marks)

INSTRUCTION: Answer ALL questions in Section A.

Please use the answer booklet provided.

Question 1

(a) Provide a sketch to describe the difference between Sourcing Input and Sinking Input.

(2 marks)

(b) Describe the PLC's 'scan time' in compliance with IEC61131.

(2 marks)

(c) It is very important to identify an appropriate PLC module for specific development. Name three technical criteria to choose an input module for PLC project.

(2 marks)

(d) IEC61131-5 explained about the compliance of standard PLC programming languages. List three of the programming languages mentioned in IEC61131-5.

(2 marks)

(e) Programmable Logic Controller is one of major achievements in mechatronic field. It has been used to replace and improve relay based industrial controller. Identify two advantages of using PLC over relay based control system.

(2 marks)

Question 2

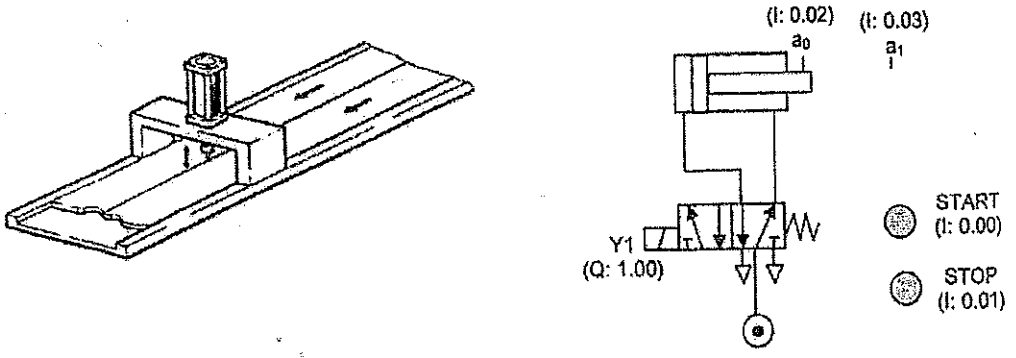

Figure 1: Pneumatic circuit.

(a) Figure 1 shows a double acting cylinder which used to break-off the welding scale from the welding seam. A typical START and STOP pushbutton employed as part of manual activation of the process. When the START pushbutton is pressed, the continuous cycle start. Meanwhile, the cylinder should stops at retracted position when the STOP pushbutton is pressed. Solve this problem based on the following requirements:

i. Input and output list table,

ii. Typical I/O wiring and connection diagram, and

iii. Ladder logic diagram for this process.

Note: All switches are normally opened type.

(9 marks)

(b) Figure 2 is an example of counting PLC ladder in automation industry. Based on the ladder diagram of the counter, identify the status of C0 and Q 15.0 if I 15.0 is ON for 5 times.

(3 marks)

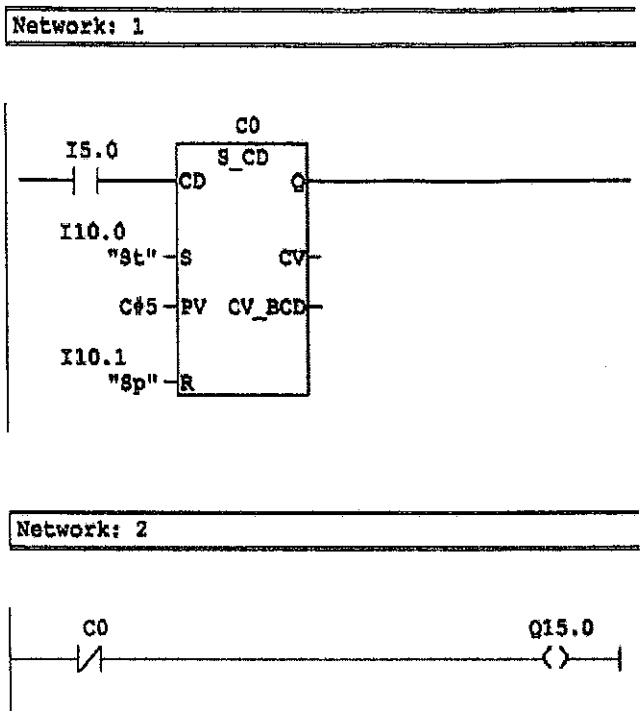

Figure 2: Counter related ladder.

(c) Figure 3 shows the ON-Delay Timer, S_ODT, of SIEMENS S7-300 PLC. Based on the ladder diagram, identify the status output Q 10.0 based on the following condition.

i. Pushbutton S1 is pressed.

ii. Pushbutton S2 is pressed.

iii. Pushbutton S1 is pressed follow by S2.

(3 marks)

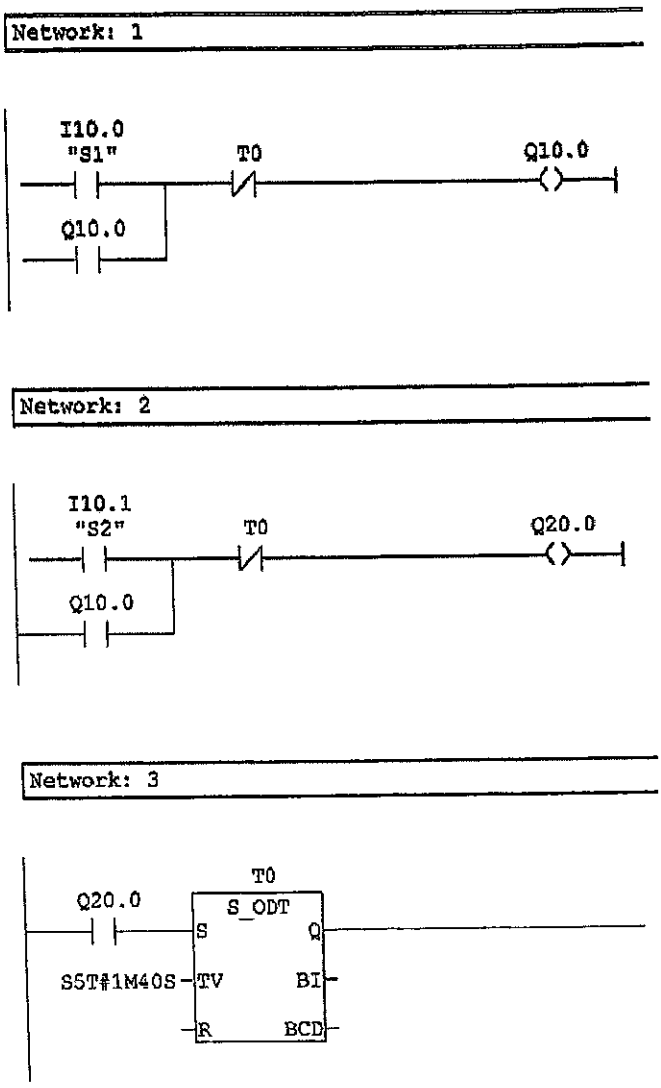

Figure 3: Timer related ladder.

Question 3

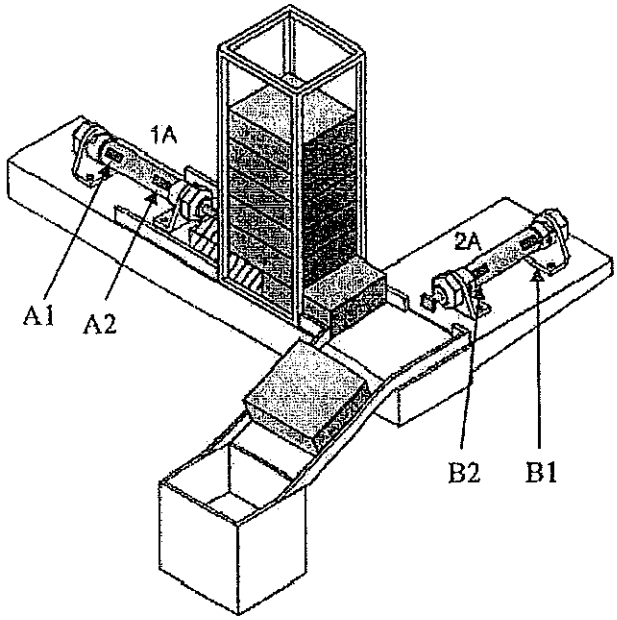

Figure 4: Transfer system.

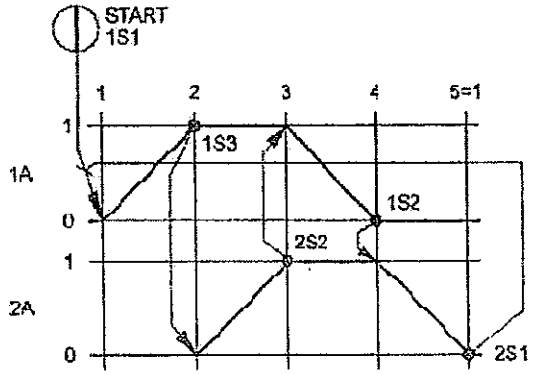

Figure 5: Step diagram for transfer system in Figure 4.

(a) Figure 4 shows a simplified transferring process in a logistic warehouse. The mechanical hardware consists of a vertical magazine, a chute, and TWO (2) double acting cylinders. At vertical magazine, parts are transferred onto a chute one at a time. Meanwhile, TWO (2) pneumatic cylinders, 1A and 2A, are controlled by a single solenoid valve. START pushbutton, S1, is employed

as activation for the continuous process cycle. The cylinders positions are determined and confirm via limit switches, A1, A2, B1 and B2. The procedure of this continuous sub-process is simplified as follows (also shown in Figure 5):

- All mechanical components are initialised,
  - cylinder 2A at position B1, and
  - cylinder 1A at position A1.
- Cylinder 1A extends to position A2 and cylinder 2A remains retract at position B1.
- Then, with cylinder 1A remains extend at position A2, cylinder 2A extends to position B2.
- When cylinder 2A reach B2, cylinder 1A will instantly retract to position A1.

i. With appropriate I and Q address, identify the relevant symbol list related to the input output devices.

(3 marks)

ii. According to the overall process sequence, deduce a PLC ladder diagram for the system.

(7 marks)

(b) A simplified bottle counting and cleaning process in a factory is shown Figure 6. At the middle of the conveyor, a photoelectric sensor is installed to detect the presence of bottle. On top of that, this sensor will also calculate the amount of bottles passing through the conveyor. On the operator side, an indicator lamp will turns ON, to indicate the sensor has count 900 bottle passed through the conveyor.

i. With appropriate I and Q address, determine the Input and Output address for the devices.

(3 marks)

ii. Illustrate the Input and Output wiring diagram of the system.

(5 marks)

iii. Based on the explanation, deduce a ladder diagram for this process.

(7 marks)

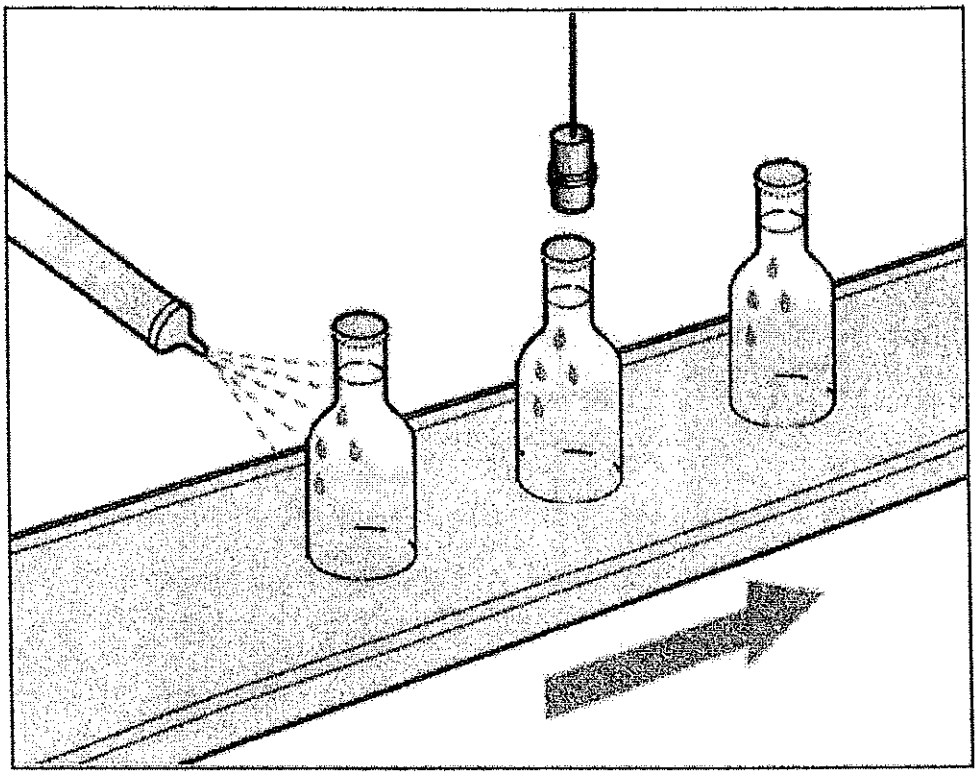

Figure 6: Bottle Counting Process.

SECTION B (TOTAL: 25 marks)

INSTRUCTION: Answer ONE (1) question in Section B.
Please use the answer booklet provided.

Question 1

Figure 7 illustrates a typical process of ice-cream manufacturing. There are TWO (2) tanks system being employed,

- tank 1 is the mixer tank to mix all the ingredient, and
- tank 2 is dedicated for cooling and storing the ice-cream product.

In addition, there are TWO (2) types of ice-cream's flavour which are,

- yam, and
- durian

The pushbuttons, S1 and S2 are for ON and OFF the system correspondingly. The selection of the flavour it set by means of a selector switch, S3. There are also FIVE (5) control valves to feed the main ingredients whereby,

V1 is for yam flavour,
V2 is for durian flavour,
V3 is for vegetable oil,
V4 is for sugar, and
V5 is for flour.

Meanwhile, THREE (3) proximity sensors are used to detect the level of mixing product in tank 1. Those sensors are,

S4 is for high-level,
S5 is for medium-level, and
S6 is for low-level.

All the main ingredients for the ice-cream recipe is shown on Table 1. Algorithm 1 summaries the process and procedure of ice-cream making for this plant. Assume this system is utilising S7-300 controller.

Table 1: Ice-cream recipe.

Flavour	Ingredients
Yam	yam flavour, vegetable oil, sugar, flour.
Durian	durian flavour, vegetable oil, sugar, flour.

Algorithm 1 Yam and durian ice-cream recipe.

INPUT: S1, S2, S3, S4, S5, S6.
OUTPUT: V1, V2, V3, V4, V5, V6, M1.

```
1: procedure (Ice Cream Machine Operation)
2:     while (S1 is switched ON) do
3:         if (S3 is select 'Yam') and (S6 is detect LOW level) then
4:             V6 will remain CLOSEd,
5:             V1, V3, V4, V5 will be OPENed for 5 seconds only, and
6:             M1 RUNs for 2 minutes only.
7:             if (S4 is detect HIGH level) then
8:                 M1 STOPs, and
9:                 V6 will be OPENed.
10:            end if
11:        else if (S3 is select 'Durian') and (S6 is detect LOW level) then
12:            V6 will remain CLOSEd,
13:            V1, V3, V4, V5 will be OPENed for 5 seconds only, and
14:            M1 RUNs for 2 minutes only.
15:            if (S4 is detect HIGH level) then
16:                M1 STOPs, and
17:                V6 will be OPENed.
18:            end if
19:        end if
20:    end while
21: end procedure
```

(a) With appropriate I and Q address, prepare the IO device list.

(6 marks)

(b) With respect to the Algorithm 1, propose a flowchart for this system.

(5 marks)

(c) Develop a PLC ladder diagram for the system according to the procedure given below for yam ice-cream only.

(7 marks)

(d) Develop a PLC ladder diagram for the system according to the procedure given below for durian ice-cream only.

(7 marks)

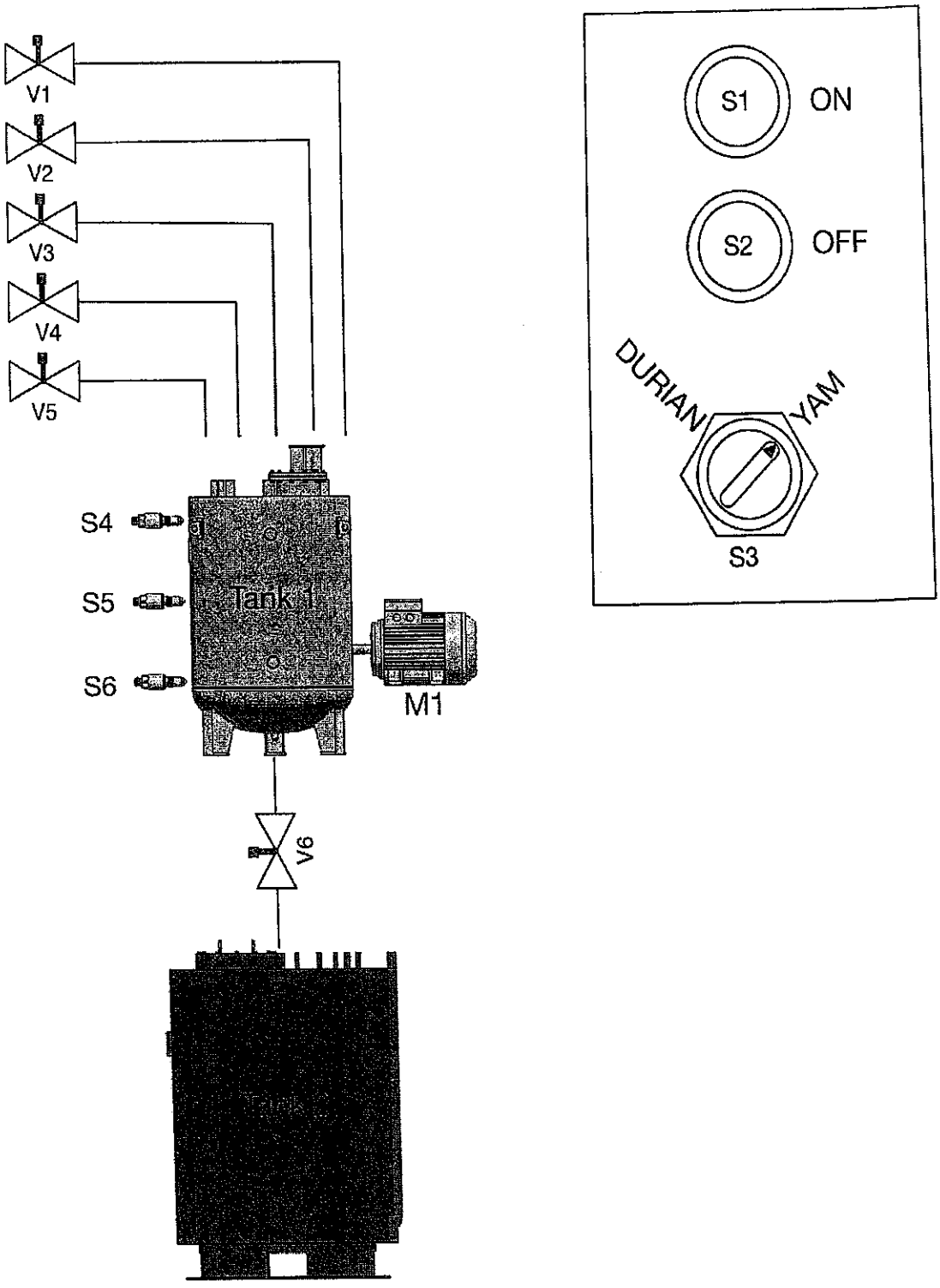

Figure 7: Ice-cream making process.

Question 2

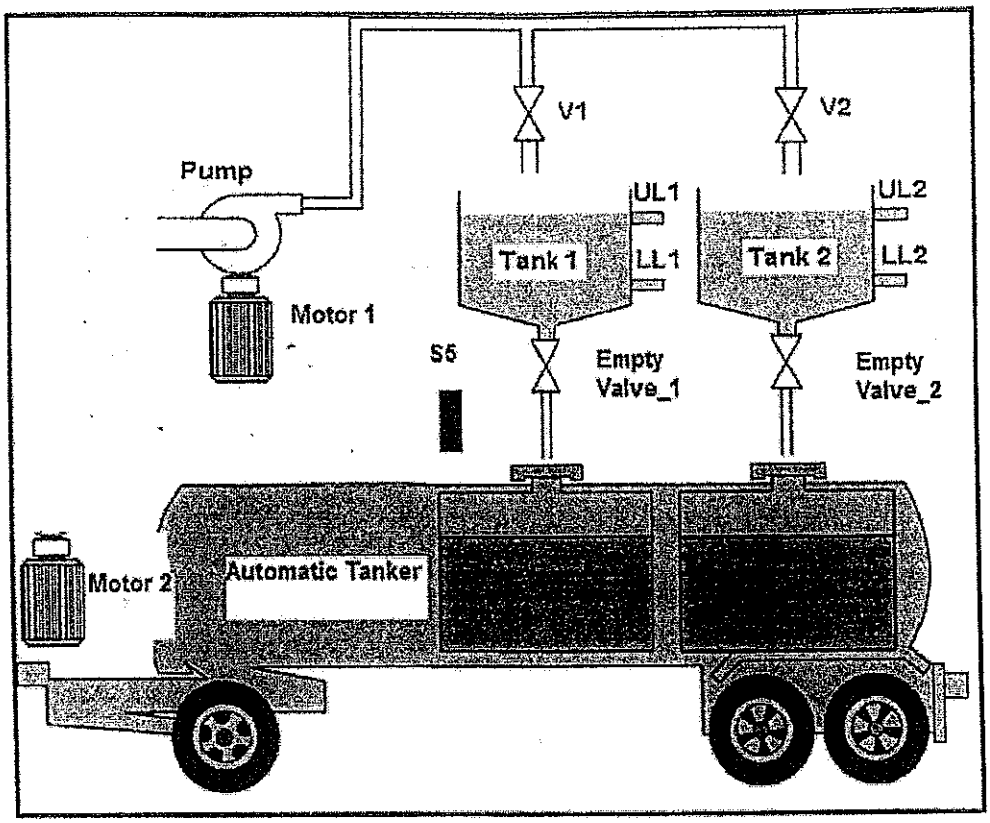

Figure 8: Automatic tank filling process.

System Operation:

- A pump is intended to fill two tanks. Two valves allow the liquid to be directed to one or other of the tanks.
- Filling is started each time the lower level (LL1 and LL2) in a tank is reached and is continued until the upper level (UL2 and UL2) is reached.
- The filling process will be done by V1 and V2. The estimate time for each valve is set to 30 seconds. The pump is stop after 30 seconds.
- Emptying is started each time the upper level (UL1 and UL2) in a tank is reached and is continued until the lower level (LL1 and LL2) is reached.
- The emptying process will be done by empty valve_1 and empty valve_2. The estimate time for each valve is set to 45 seconds.

- After time done for both empty valves, the automatic tanker will move and come back to filling system. The duration for automatic tanker to move forward and reverse is about 25 seconds for each direction. The photoelectric sensor S5 is to detect the present of tanker.
- Once the six cycles complete, the system is stop until operator press the reset push button.

Remarks:

- All the valves are of the single action type.
- After first cycle, the system will start automatically by using shift register.
- The empty process for automatic tanker is not taken into account.

Recommend a ladder diagram to fulfill the following statements:

(a) Network 1: Master control relay is ON and internal bits for shift register activation.

(3 marks)

(b) Network 2: Shift register instruction block.

(4 marks)

(c) Network 3: Sequence control.

(3 marks)

(d) Network 4: Pump activation and filling process for 30 seconds.

(3 marks)

(e) Network 5: Emptying process for 45 seconds.

(3 marks)

(f) Network 6: Automatic tanker moving to the left for 25 seconds.

(3 marks)

(g) Network 7: Automatic tanker moving to the right for 25 seconds and automatic restart for next cycle.

(3 marks)

(h) Network 8: Counting six cycles.

(3 marks)

END OF EXAMINATION PAPER