UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE : FAD 30502
SUBJECT TITLE : PROGRAMMABLE LOGIC CONTROLLER 2
LEVEL : DIPLOMA
TIME / DURATION : 12.30pm – 2.30pm ( 2 HOURS )
DATE : 10 NOVEMBER 2010

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. Please write your answers on the answer booklet provided.

4. Answer should be written in blue or black ink except for sketching, graphic and illustration.

5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) questions only.

6. Answer all questions in English.

THERE ARE 9 PAGES OF QUESTIONS AND 4 PAGES OF APPENDIX, EXCLUDING THIS PAGE.
SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions. Please use the answer booklet provided.

Question 1

(a) Base on Figure 1, determine the network type for the PLC. 

(b) Explain the procedure to download the program in CX programmer into PLC.

(c) Explain the procedure to edit the program on-line.

Question 2

(a) Define the name of instruction block in Omron PLC similar to Sequence Function Chart (SFC).

(b) Give two advantage of using SFC compare to other PLC languages.
(c) Answer all the question below by referring figure 2 below

![Ladder Diagram]

**Figure 2**: Ladder Diagram

1. Give the numerical address for P_ON and P_1s. (2 marks)
2. Determine the clock pulse for SHIFT REGISTER. (2 marks)
3. Determine the Input for SHIFT REGISTER. (2 marks)
4. Determine the Starting Word and Ending Word. (4 marks)

**Question 3**

Answer all the question based on the following statement:

- Press push button 1 (00000) then released, internal bit 01700 will ON. It will stop when we press the stop button (00001)
- When Internal bit equal to `1`, it will be calculate the value $99_{BCD} + 69_{BCD}$ and store the result in HR001, the indicator lamp 10000 will ON when there is a carry in this operation, but if there is no carry, the output 10000 is OFF.
- The value in HR001 will always **MOVE** to address HR003.
- When the internal bit 01700 is equal to 1, Move $150_{BCD}$ to HR004.
- The program will always compare the value between HR003 and HR004. The result of comparison must be respect all the condition below.

<table>
<thead>
<tr>
<th>data</th>
<th>10002</th>
<th>10003</th>
<th>10004</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR003 &gt; HR004</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>HR003 = HR004</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>HR003 &lt; HR004</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
</tbody>
</table>
(a) Design the ladder diagram for explanation above.  

(b) Determine the mathematical expression exist in this ladder diagram?  

(c) Define the result in HR003?  

(d) Show and calculate the details of these mathematical operations.  

(e) Change the value of $99_{BCD}$ to $9999_{BCD}$.
   i. Define the value of HR003  
      (2 marks)  
   ii. Which outputs will ON? Explain what is the reason.  
      (3 marks)  

Question 4

Explain how to set DM6611 based on the following requirements:

- 1 unit of temperature sensor (range 0mA DC to 20mA DC), connected to input analog channel 1.
- 1 unit of pressure transducer (4mA DC to 20mA DC), connected to input analog channel 2
- 1 unit of level transducer (0V DC to 5V DC) connected to input analog channel 3
- 1 unit of flow sensor (0V DC to 10V DC) connected to input analog channel

The PLC used in this application is **OMRON CQM1H**. (Refer to appendix given in page 11-14)  

(8 marks)
SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO questions only.
Please use the answer booklet provided.

Question 5

Figure 3: Part sorting system

- When push button is pressed, the conveyor will move and remain until stop button is pressed.
- The clock input sensor serves as the shift data (clock pulse) of the shift register.
- The parts are spaced equally from each others.
- The signal from the inspection station (Sensor input 00001) serves as the data input of the shift register.
- When a defective product is detected, the parts are traced by a shift register until the part arrives at position 5 where it is rejected by a compression air ejection.
Answer these questions:

(a) State all the Input and Output list for this system

(b) Draw the PLC input and Output wiring.

(c) Design the ladder diagram for the system by following the requirements below.
   - Main conveyor
   - Shift registers instruction. (Use HR10)
   - Position 1 until position 5

(4 marks)

(4 marks)

(12 marks)
Question 6

Boiling System

![Diagram of boiling system]

**Figure 4**: Water boiling system

Figure 4 above shows the boilers which consist of one temperature sensor, one level sensor and one heater.

The boiling operations are as follows:

- The heater will heat the water with the variation of heating element works from 0% to 100%. The heater works only at dc voltage given from 0Vdc until 10Vdc.
- The temperature sensor PT500 sense the temperature of the water from 0°Celsius to the maximum of 100°Celsius. This sensor equipped with a transducer who converts the temperature range to an analog signal.
- The level sensor permits to sense the level of water in the tank so that the boiling process may be done efficiently depending on the level of water. The transducer converts the level measurement 0cm - 200cm into analog signals.

A PLC CQM1H has been chosen to control this boiling system. In order to deal with the analog processing control an Analog Inner Board MAB42 which it consist of 4 channels of analog inputs and 2 channels of analog outputs. The Temperature sensor is connected input channel 1 while the Level sensor is connected to channel no 3. The output heater is connected to output channel 1 of the MAB42.
The setting for analog inputs channels in DM6611 is in Figure 5.

\[
\text{DM6611} = \begin{array}{c}
0 \\
A \\
1 \\
2
\end{array}
\]

*Figure 5: setting result*

(a) Refer to Appendix 3, determine the address of the Temperature sensor in the PLC register and what type of signal injected into this channel.

(2 marks)

(b) Refer to Appendix 3, determine the address of the Level sensor in the PLC register and what type of signal injected into this channel.

(2 marks)

(c) A partial program: Design the ladder based on the following requirements.

i. If the start Push Button (IR 0.00) is pressed, internal bit 18.00 will ON, and remain ON unless the Stop Push Button (IR 0.01) is pressed.

(2 marks)

ii. Data from the Internal Register associated to Temperature sensor will always be transferred to DM0.

(2 marks)

iii. Data from the Internal Register associated to Level sensor will always be transferred to DM1.

(2 marks)

iv. If the temperature sensor senses the temperature of 100° celcius, then the internal bit 16.00 will ON.

(2 marks)

v. If the level sensor detect the level of water is more than 1m (and equal), internal bit 16.01 will ON.

(2 marks)

vi. If internal bit 16.00 is OFF and 16.01 is ON the Heater will on for 80%.

(3 marks)

vii. If internal bit 16.00 is OFF and 16.01 is OFF the Heater will on for 40%.

(3 marks)
Question 7

ALAMANDA Air conditioning system

Carrefour Alamanda management is upgrading their air-conditioning system to ensure a better condition for their customers. A new engineer, graduated from MFI, has been given a task to improve the system. He needs to make some calculation based on the existing equipment. The air-conditioning system should run automatically, with the set value given.

The equipment involved are:

1. A temperature sensor with sensing range of 10°Celsius to 50°Celsius.
2. The sensor connected to a transducer that converts the temperature from 0Vdc to 10Vdc.
3. An Omron PLC CQM1H with the Analog Input/Output card MAB-42 that can convert the analog value to 12bits binary data. (refer Appendix 1, 2, 3, and 4)

![Diagram](image)

**Figure 6**: Data conversion from sensor to PLC register

(a) Complete the Table 2 below. *(you have to redraw the complete table in your answer booklet)*

(4 marks)

<table>
<thead>
<tr>
<th>Temperature (°Celsius)</th>
<th>Output Transducer (Vdc)</th>
<th>12 bits data converted</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0</td>
<td>0000 0000 0000</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>10</td>
<td>1111 1111 1111</td>
</tr>
</tbody>
</table>
(b) Draw a curve temperature (°C) versus Output transducer (Vdc) where the equation of the curve is \( Y = mX + C \). Find the value of \( m \) and \( C \). 

(5 marks)

(c) Find the value of \( m \) and \( C \) if the transducer can only produce 0Vdc to 5Vdc for the temperature value of 0°C to 50°C.

(2 marks)

(d) From Appendix 3 what is the address of the register associated to the analog input channel 2?

(2 marks)

(e) Design a ladder diagram where the value read from the analog input channel 2 is compared to the value 00FF\text{HEX}. If the read value is greater than 00FF\text{Hex} then output 10001 will energize. If the read value is less than or equal to 00FF\text{HEX} then output 10002 will energize.

(7 marks)

END OF QUESTION
Analog I/O Board

Related PC Setup Settings    None

2-5  Analog I/O Board

2-5-1  Model

<table>
<thead>
<tr>
<th>Name</th>
<th>Model</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog I/O Board</td>
<td>CQM1H-MAB42</td>
<td>4 analog inputs (−10 to +10 V; 0 to 5 V; 0 to 20 mA; separate signal range for each point)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 analog outputs (−10 to +10 V; 0 to 20 mA; separate signal range for each point)</td>
</tr>
</tbody>
</table>

2-5-2  Function

The Analog I/O Board is an Inner Board featuring four analog inputs and two analog outputs.

The signal ranges that can be used for each of the four analog input points are −10 to +10 V, 0 to 5 V, and 0 to 20 mA. A separate range is set for each point.

The settings in DM 6611 determine the signal ranges.

The signal ranges that can be used for each of the two analog output points are −10 to +10 V and 0 to 20 mA. A separate signal range can be selected for each point. The settings in DM 6611 determine the signal range.

2-5-3  System Configuration
APPENDIX 2

Analog I/O Board

The output signal connections to CN2 depend on whether the output signals are voltage outputs or current outputs. The following diagrams show the correct wiring in each case.

8-5-8 Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Analog I/O Board</td>
</tr>
<tr>
<td>Model number</td>
<td>CQM1H-MAB42</td>
</tr>
<tr>
<td>Applicable CPU Unit</td>
<td>CQM1H-CPU51/61</td>
</tr>
<tr>
<td>Unit classification</td>
<td>CQM1H-series Inner Board</td>
</tr>
<tr>
<td>Mounting locations and number of</td>
<td>1 Board in Inner Board slot 2 (right slot)</td>
</tr>
<tr>
<td>Boards</td>
<td></td>
</tr>
<tr>
<td>Analog inputs</td>
<td>4 inputs (Refer to Analog Inputs below for details)</td>
</tr>
<tr>
<td>Analog outputs</td>
<td>2 outputs (Refer to Analog Outputs below for details)</td>
</tr>
<tr>
<td>Isolation method</td>
<td>Between inputs and PC: Photocoupler isolation</td>
</tr>
<tr>
<td></td>
<td>Between inputs: No isolation</td>
</tr>
<tr>
<td>Settings</td>
<td>None</td>
</tr>
<tr>
<td>Indicators</td>
<td>2 LED indicators on front panel: Ready (RDY) and Error (ERR)</td>
</tr>
<tr>
<td>Front connection section</td>
<td>Connectors CN1 and CN2 (Compatible connector: Sockets &amp; connectors provided as standard accessories.)</td>
</tr>
<tr>
<td>Current consumption (Supplied from</td>
<td>6 V DC 400 mA max</td>
</tr>
<tr>
<td>Power Supply Unit)</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>25 x 110 x 107 mm (W x H x D)</td>
</tr>
<tr>
<td>Weight</td>
<td>100 g max</td>
</tr>
<tr>
<td>Standard accessories</td>
<td>Sockets XM2D-1601 (OMRON) x 2</td>
</tr>
<tr>
<td></td>
<td>Hoods XM2S-1511 (OMRON) x 2</td>
</tr>
</tbody>
</table>
### APPENDIX 3

#### Analog I/O Board

**Section 2-5**

<table>
<thead>
<tr>
<th>Relevant Bits</th>
<th>Bits Used by Inner Board in Slot 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word</strong></td>
<td><strong>Bits</strong></td>
</tr>
<tr>
<td>IR 232</td>
<td>00 to 15</td>
</tr>
</tbody>
</table>
| IR 233 | 00 to 15 | Analog input 2 converted value | -10 to +10 V: 0000 to 0FFF Hex  
0 to 10 V: 0000 to 0FFF Hex  
0 to 5 V/I: 0000 to 0FFF Hex |
| IR 234 | 00 to 15 | Analog input 3 converted value | |
| IR 235 | 00 to 15 | Analog input 4 converted value | |
| IR 236 | 00 to 15 | Analog output 1 setting | The setting of each output from the Analog I/O Board is stored as a 4-digit Hex. (Read each cycle.) |
| IR 237 | 00 to 15 | Analog output 2 setting | -10 to +10 V: F800 to 0FFF Hex  
0 to 20 mA: 0000 to 0FFF Hex |

<table>
<thead>
<tr>
<th><strong>SR Area Flags</strong></th>
<th><strong>Function</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Word</td>
<td>Bit</td>
</tr>
<tr>
<td>SR 254</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>AR Area Flags</strong></th>
<th><strong>Function</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Word</td>
<td>Bits</td>
</tr>
</tbody>
</table>
| AR 04 | 08 to 15 | Error codes for Inner Board in slot 2  
00 Hex: Normal  
01 or 02 Hex: Hardware error  
03 Hex: PC Setup error  
04 Hex: A/D or D/A conversion error |

<table>
<thead>
<tr>
<th>Relevant PC Setup Settings</th>
<th><strong>Function</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word</strong></td>
<td><strong>Bits</strong></td>
</tr>
<tr>
<td>DM 6511</td>
<td>00 to 07</td>
</tr>
</tbody>
</table>
00, 01: Analog input 1 input signal range  
02, 03: Analog input 2 input signal range  
04, 05: Analog input 3 input signal range  
06, 07: Analog input 4 input signal range |  
00: -10 to +10 V  
01: 0 to 10 V  
10: 0 to 5 V/I to 20 mA  
11: Not used. (0 to 20 mA are distinguished by the connected terminal.) |
| | 08 | Analog input 1 usage selection | Specifies use or non-use of A/D conversion for each port. |
| | 09 | Analog input 2 usage selection | 0: Use input (conversion)  
1: Do not use input (no conversion) |
| | 10 | Analog input 3 usage selection | |
| | 11 | Analog input 4 usage selection | |
| | 12 to 15 | Not used. (Fixed at 0.) | |

**Note**  
The level of the analog output signal is determined by the connected terminal, and there is no PC Setup setting. These settings are reflected in status at power ON.
2-5-6 Specifications

Analog Inputs: Input Data and Converted Values

-10 to +10 V

-10 V
<table>
<thead>
<tr>
<th>5 V</th>
<th>0 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 Hex</td>
<td>07FF Hex</td>
</tr>
<tr>
<td>+5 V</td>
<td>+10 V</td>
</tr>
</tbody>
</table>

Converted value (12-bit binary data)

Analog input signal

0 to +10 V

-10 V
<table>
<thead>
<tr>
<th>5 V</th>
<th>0 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 Hex</td>
<td>0FF Hex</td>
</tr>
<tr>
<td>+5 V</td>
<td>+10 V</td>
</tr>
</tbody>
</table>

Converted value (12-bit binary data)

Analog input signal

0 to 5 V or 0 to 20 mA

-10 V
<table>
<thead>
<tr>
<th>5 V</th>
<th>0 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 Hex</td>
<td>0FFF Hex</td>
</tr>
<tr>
<td>10 mA</td>
<td>20 mA</td>
</tr>
</tbody>
</table>

Converted value (12-bit binary data)

Analog input signal

Analog Outputs: Settings and Output Data

-10 to +10 V

0 to 20 mA

-10 V
<table>
<thead>
<tr>
<th>5 V</th>
<th>0 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 Hex</td>
<td>0FF Hex</td>
</tr>
<tr>
<td>10 mA</td>
<td>20 mA</td>
</tr>
</tbody>
</table>

Setting (12-bit binary data)

Analog output signal

Applications Examples

The Board uses no special instructions. MOV(21) is used to read analog input values and set analog output values.