SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
SEPTEMBER 2013 SESSION

SUBJECT CODE	:	**FED 20203**
SUBJECT TITLE	:	**INDUSTRIAL MOTOR CONTROL**
LEVEL	:	**DIPLOMA**
TIME / DURATION	:	**2.5 HOURS**
DATE	:	

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) question only.

6.   Answer all questions in English.

7.   Do not open the question paper until instructed to do so.

THERE ARE 6 PAGES OF QUESTIONS, EXCLUDING THIS PAGE AND APPENDIX.

SECTION A (Total: 60 marks)

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

Question 1

(a)   State the function and draw the circuit symbol for each of the components as listed below:

(i)   Push Button

(ii)   Isolator

(iii)   Thermal Overload Relay

(9 marks)

(b)   Explain briefly two (2) differences between contactor and control relay.

(4 marks)

(c)   List three (3) types of conventional motor starter.

(3 marks)

(d)   Choose the correct connection for the motors as shown in Table 1. **(Please provide the answer in the answer booklet)**.
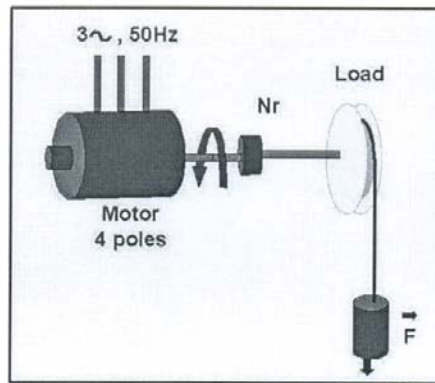
(4 marks)

Table 1

No	MOTOR	Line Voltage Of the Supply	Connection
1	240 / 415	415	Star ☐ Delta ☐
2	240 / 415	240	Star ☐ Delta ☐
3	415 / 719	415	Star ☐ Delta ☐
4	138 / 240	240	Star ☐ Delta ☐

Quesion 2

(a)   A 240 V / 415 V induction motor with line voltage, V_L = 240 V and phase current, I_P = 1.95 A. Determine:

   (i)   The suitable connection to the motor winding

   (ii)   The phase voltage, **V_P**

   (iii)   The line current, **I_L**

                                                                          (5 marks)

(b)   Referring to **Figure 1**, calculate the rotor speed if the slip, *s* is equal to 3% and the supply frequency is 50 Hz.

                                                                          (3 marks)

Figure 1

(c)   A 3-phase 240 / 415 V induction motor as a main actuator and the stator windings is STAR-connected. **Table 2** shows the motor specifications. Determine:

   (i)   The electrical power, **P_e**.

   (ii)   The efficiency of the motor, **η**.

   (iii)   The torque produced by the motor, **T**.

                                                                          (12 marks)

Table 2

3-phase Induction Motor Specifications:					
V	Hz	min^{-1}	kW	cos φ	A
Δ 220/230	50	1480	0.75	0.85	3.35
Δ 240	50	1500	0.75	0.8	3.35
Y 380/400	50	1480	0.75	0.85	1.95
Y 415	50	1500	0.75	0.8	1.95

Question 3

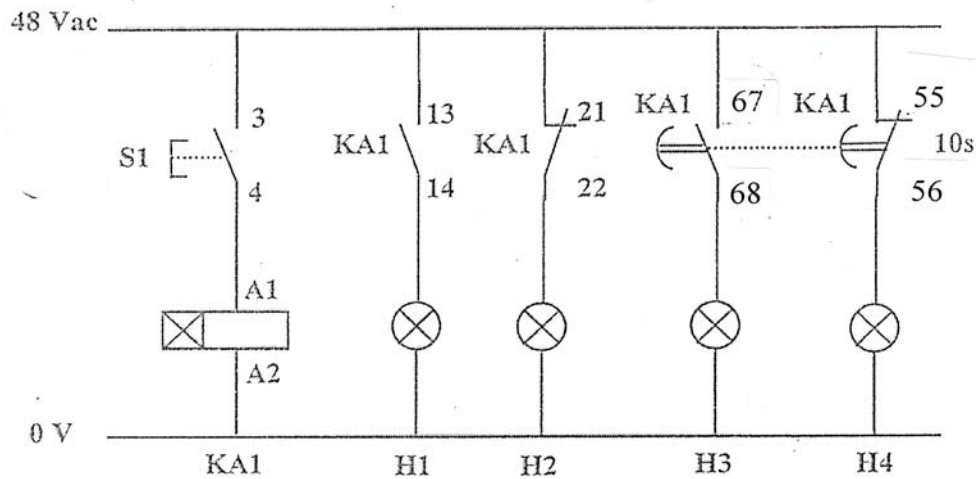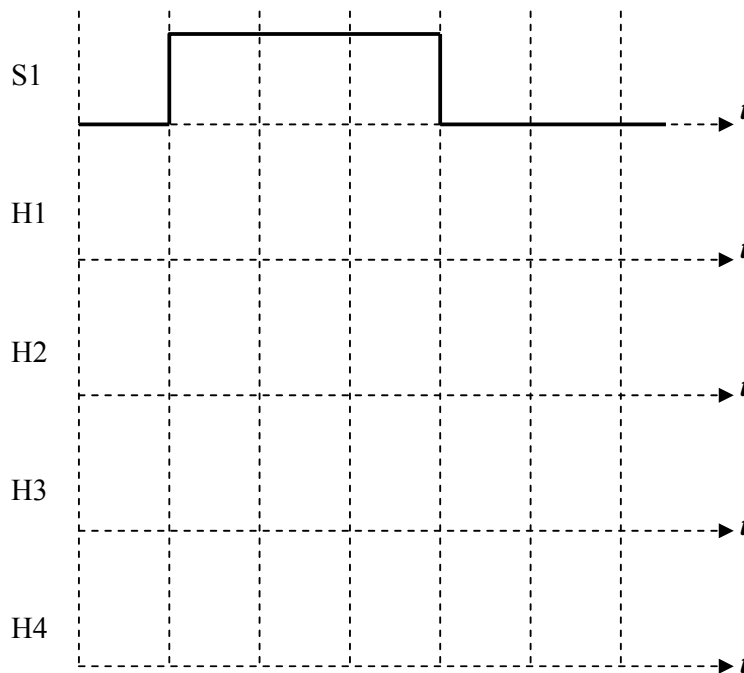(a)   Describe the function of ON Delay and OFF Delay.

(4 marks)

(b)   Refer to **Figure 2**:

(i)   Name the Time Delay Relay (Timer) used in **Figure 2** and explain its function.

(ii)   Explain the operation of the circuit as shown in **Figure 2**.

(iii)   Complete the timing diagram in **Figure 3**. *(Please provide the answer in the answer booklet)*.

(16 marks)

Figure 2

Figure 3

SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO (2) questions.
Please use the answer booklet provided.

Question 4
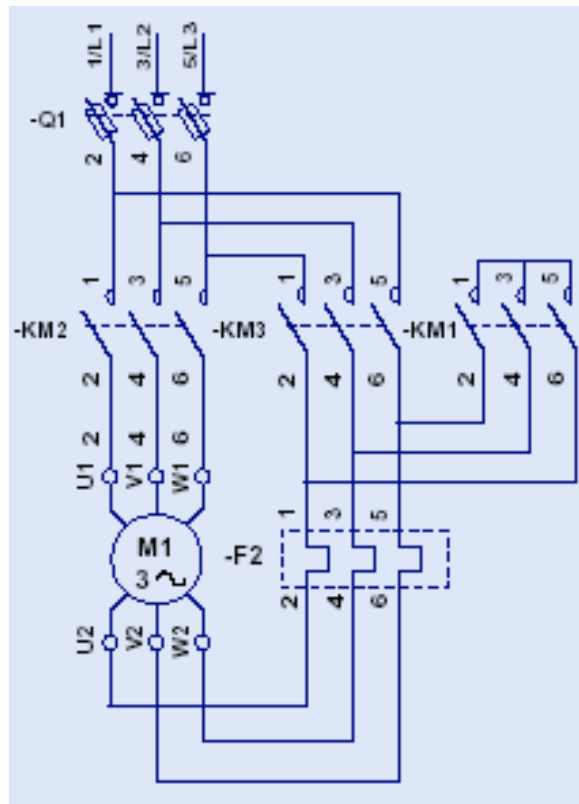

(a)   State three (3) advantages of direct on line starting method compared to others
        starting method.

                                                                                    (3 marks)

(b)   Explain briefly two (2) disadvantages of direct on line starting method compared to
        reduce voltage starting method.

                                                                                    (4 marks)

(c)   Draw the graph of current / speed characteristics for direct on line starter.

                                                                                    (3 marks)

(d)   A 3-phase, 6 poles, 50 Hz induction motor take 60 A at full-load speed 940 RPM and
        develop a torque of 150 Nm. The starting current at rated voltage is 300 A.

        (i)   Calculate the starting torque.

        (ii)   If Star-Delta Starter is used, determine the starting torque and the starting
                current.

                                                                                    (10 marks)

Question 5

Figure 4 shows a power diagram of manual drilling machine with Star-Delta Starting method.

(a)   Draw the control diagram for Star-Delta starter with 48 Vac.

(6 marks)

(b)   Sketch the speed versus starting current characteristic graph for a Star-Delta starter.

(4 marks)

(c)   State four (4) disadvantages of Star-Delta starter compared to the other starters.

(4 marks)

(d)   An Induction motor with short-circuit current at normal voltage is 6 times the full load current and the full load slip is 4 %. If magnetizing current is neglected, determine the starting torque in terms of full load torque when started with:

    (i)   Star-Delta starting method

    (ii)   Autotransformer starting method, with 70.7% tapping.

(6 Marks)

Figure 4

Question 6

(a)   **Figure 5** shows the power diagram of an Autotransformer starter. Design the control diagram for an Autotransformer starter.
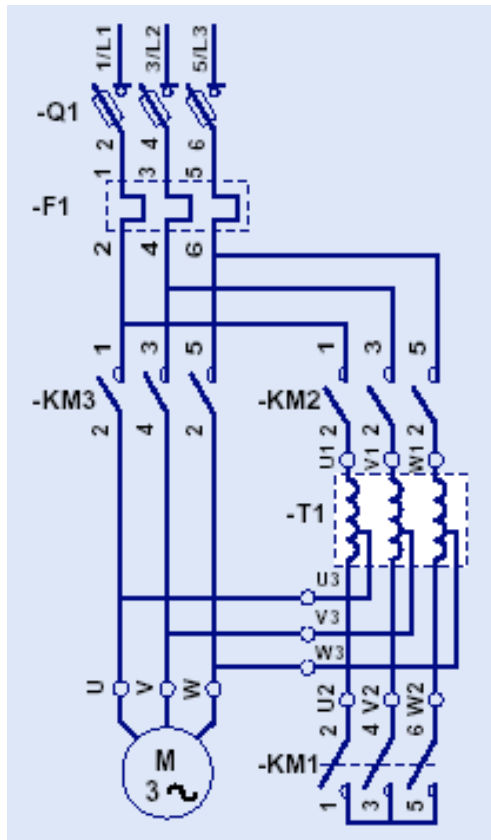
(10 Marks)

(b)   List three (3) advantages and three (3) disadvantages of Autotransformer starting method.

(6 Marks)

(c)   Draw the graph of current / speed characteristics for Autotransformer starting method.

(4 Marks)

Figure 5

END OF QUESTION PAPER

APPENDIX

Useful formula:

1. Electrical Power:

   $P_e = V_L I_L \sqrt{3} \cos \varphi$

2. Mechanical Power:

   $P_m = T\Omega$

3. Rotor Speed (Motor Speed)

   $$N_r = \frac{120(1-s)f}{p}$$

4. Direct On Line Starting Method:

   $$\frac{T_{st}}{T_f} = \left(\frac{I_{sc}}{I_f}\right)^2 . s_f$$

5. Star-Delta Starting Method

   $$\frac{T_{st}}{T_f} = \frac{1}{3}\left(\frac{I_{sc}}{I_f}\right)^2 . s_f$$

6. Auto-Transformer Starting Method

   $$\frac{T_{st}}{T_f} = K^2\left(\frac{I_{sc}}{I_f}\right)^2 . s_f$$