Assignment 1

Digital Engineering

Made by:

Mostafa Essam El-din Badr

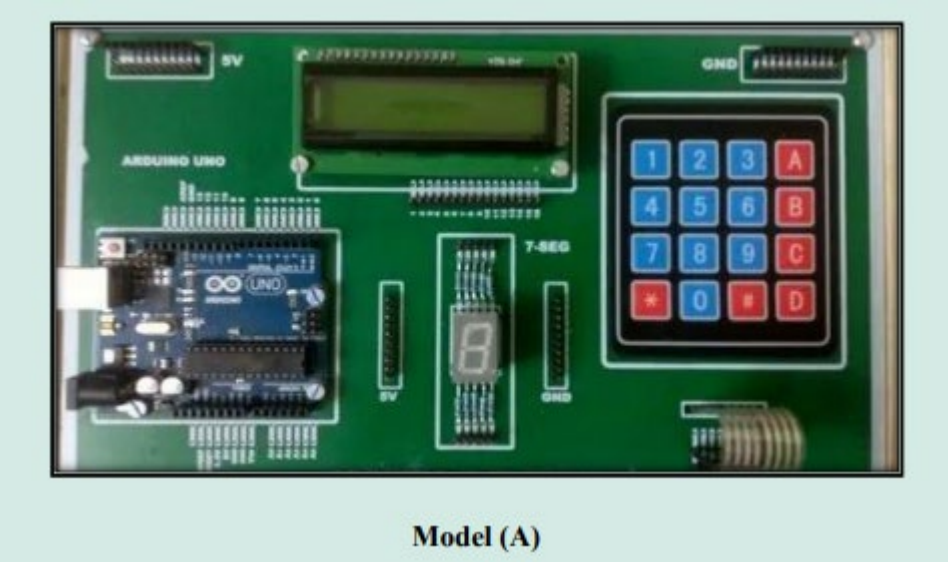
Supervised by:

Dr. Hatem

Eng. Eman Osama

Task 1:

1. **Identify the main components of the given Digital Kit Products model (A) and Model (B) as shown in Figure (1), Compare and contrast between the two models, which one is described in the scenario.**



Model (A)

components	usage
Arduino Uno R3	-- is a microcontroller board at the heart of the Arduino platform. It features the ATmega328P microcontroller, offering 14 digital I/O pins, 6 PWM outputs, 6 analog inputs, USB connectivity for programming, a reset button, and compatibility with a wide range of sensors and expansion modules. Widely used for prototyping, and education, its open-source nature, ease of programming with the Arduino IDE.
7-seg display	-- Display numbers or letters -- Show sensor values gas level (in this example)
4x4 Matrix Keypad	-- Input user data or perform specific actions by pressing different combinations.
Lcd 16x2	-- Print messages or prompts for user interaction in your projects.

Model (B)

components	usage
Arduino Uno	-- is a microcontroller board at the heart of the Arduino platform. It features the ATmega328P microcontroller, offering 14 digital I/O pins, 6 PWM outputs, 6 analog inputs, USB connectivity for programming, a reset button, and compatibility with a wide range of sensors and expansion modules. Widely used for prototyping, and education, its open-source nature, ease of programming with the Arduino IDE.
7-seg display	-- Display numbers or letters -- Show sensor values gas level (in this example)
Lcd 16x2	-- Print messages or prompts for user interaction in your projects.
Dip switch spst x4	-- Use them as configuration switches for different modes or settings in your project. -- Assign specific tasks or values to each switch position.
Buzzer	-- Create an alarm system for security or safety purposes. -- Use it for generating different tones or melodies for notifications.
Gas sensor (Smoke sensor)	-- Detect gas/smoke presence in the environment.
Led Input/output	-- Use as indicators to show the status of a system (on/off, active/inactive, etc.). -- Create visual feedback for different actions or events in your project.

Which one is described in the scenario?

Model (A)

2. **For the given logic function, explain its operation, make a good use of Boolean algebra and Truth Tables. And, sketch the logic diagram of the given logic function.**

The logic function is Q = (A'BC' + A'B'C)'.

Truth table:

A	B	C	A'	B'	C'	A'BC'	A'B'C	A'BC'+A'B'C	Q
0	0	0	1	1	1	0	0	0	1
0	0	1	1	1	0	0	1	1	0
0	1	0	1	0	1	1	0	1	0
0	1	1	1	0	0	0	0	0	1
1	0	0	0	1	1	0	0	0	1
1	0	1	0	1	0	0	0	0	1
1	1	0	0	0	1	0	0	0	1
1	1	1	0	0	0	0	0	0	1

Sketch the logic diagram:

3. **Convert the decimal input to the binary format. And the output to hexadecimal format.**

Decimal to binary

	C	B	A	Q = (A'BC'+A'B'C)'
6	1	1	0	**Q1 = (110+101)' = (0+0)' =1**
3	0	1	1	**Q2 = (011+000)' = (0+0)' =1**
2	0	1	0	**Q3 = (111+100)' = (1+0)' =0**
5	1	0	1	**Q4 = (000+011)' = (0+0)' =1**

Binary to hexadecimal

1011	11 = B

4. **Critically analyze the input and output methods for the Boolean expression of the given logic function when it has been processed using kit model (A) and model (B) in terms of component blocks in each kit as shown in Figure (1).**

In Model (A), the input of decimal numbers via a 4x4 matrix keypad is feasible, albeit restricted to values up to 7 due to the current function's limitation with only 3 binary inputs. This issue can be resolved by altering the logic function to accommodate 4 binary inputs. Subsequently, the output will be displayed on an LCD.

Conversely, in Model (B), the utilization of a 4x4 matrix keypad prevents the input of decimal numbers, rendering it incompatible with the logic function required for generating the necessary output.

Task 2:

1. **Simplify the given logic function and write a step by step simplification process with Logic Rules. Then, check the simplified with the given function.**

Simplify Q = (A'BC'+A'B'C)'

Demorgans law \ (A'BC')' . (A'B'C)'

Demorgans law \ (A''+B'+C'') . (A''+B''+C')

A"= A | (A+B'+C) . (A+B+C')

AA+AB+AC'+B'A+B'B+B'C'+CA+CB+CC'

AA = A \ A'A = 0 | A+AB+AC'+B'A+0+B'C'+CA+CB+0

A+AB+AC'+B'A+B'C'+CA+CB

Commutative law \ A+AB+AC'+CA+B'A+B'C'+CB

1+A=1 | A (1+1 . B+1 . C'+C . 1+B' . 1) + B'C'+CB

A . 1 = A | A . 1 +B'C'+CB

After Simplify = A+B'C'+CB

Truth table

A	B	C	B'	C'	B'C'	CB	A+B'C'+CB
0	0	0	1	1	1	0	1
0	0	1	1	0	0	0	0
0	1	0	0	1	0	0	0
0	1	1	0	0	0	1	1
1	0	0	1	1	1	0	1
1	0	1	1	0	0	0	1
1	1	0	0	1	0	0	1
1	1	1	0	0	0	1	1

Sketch the logic diagram after simplify:

2. **Identify the Minterm and Maxterm terms of the given logic function.**

Minterm If input A=1 , it should A If input A=0 , it should A'	**Maxterm** If input A=0 , it should A If input A=1 , it should A'	
A'B'C'	**A+B+C**	**000 = 0**
A'B'C	**A+B+C'**	**001 = 1**
A'BC'	**A+B'+C**	**010 = 2**
A'BC	**A+B'+C'**	**011 = 3**
AB'C'	**A'+B+C**	**100 = 4**
AB'C	**A'+B+C'**	**101 = 5**
ABC'	**A'+B'+C**	**110 = 6**
ABC	**A'+B'+C'**	**111 = 7**

(SOP) Minterm | Q (sop / minterm) = ∑ (0, 3, 4, 5, 6, 7)
A'B'C' + A'BC + AB'C' + AB'C + ABC' + ABC

(POS) Maxterm | Q (pos / maxterm) = π (1, 2)
(A+B+C') (A+B'+C)

3. **Represent the given logic function in terms of the Sum of Product (SOP) expression.**

   (SOP) Minterm | Q (sop / minterm) = ∑ (0, 3, 4, 5, 6, 7)
   A'B'C' + A'BC + AB'C' + AB'C + ABC' + ABC

4. **Use Karnaugh Map (K-Map) to simplify the given logic function. Then, check the simplified with the given function output.**

   Logic function BY (SOP) = A'B'C' + A'BC + AB'C' + AB'C + ABC' + ABC

	B' 0	**B' 0**	**B 1**	**B 1**
A' 0	M0 = A'B'C'	**M1 = A'B'C**	**M3 = A'BC**	**M2 = A'BC'**
A 1	**M4 = AB'C'**	**M5 = AB'C**	**M7 = ABC**	**M6 = ABC'**
	C' 0	**C 1**	**C 1**	**C' 0**

   K-map = A+B'C'+BC

5. **Evaluate the simplification method according to the worst-case simplification scenario.**

Simplify Q = (A'BC'+A'B'C)'

Demorgans law \ (A'BC')' . (A'B'C)'

Demorgans law \ (A''+B'+C'') . (A''+B''+C')

A"= A | (A+B'+C) . (A+B+C')

AA+AB+AC'+B'A+B'B+B'C+CA+CB+CC'

AA = A \ A'A = 0 | A+AB+AC'+B'A+0+B'C+CA+CB+0

A+AB+AC'+B'A+B'C'+CA+CB

Commutative law \ A+AB+AC'+CA+B'A+B'C+CB

1+A=1 | A (1+1 . B+1 . C'+C . 1+B' . 1) + B'C+CB

A . 1 = A | A . 1 +B'C+CB

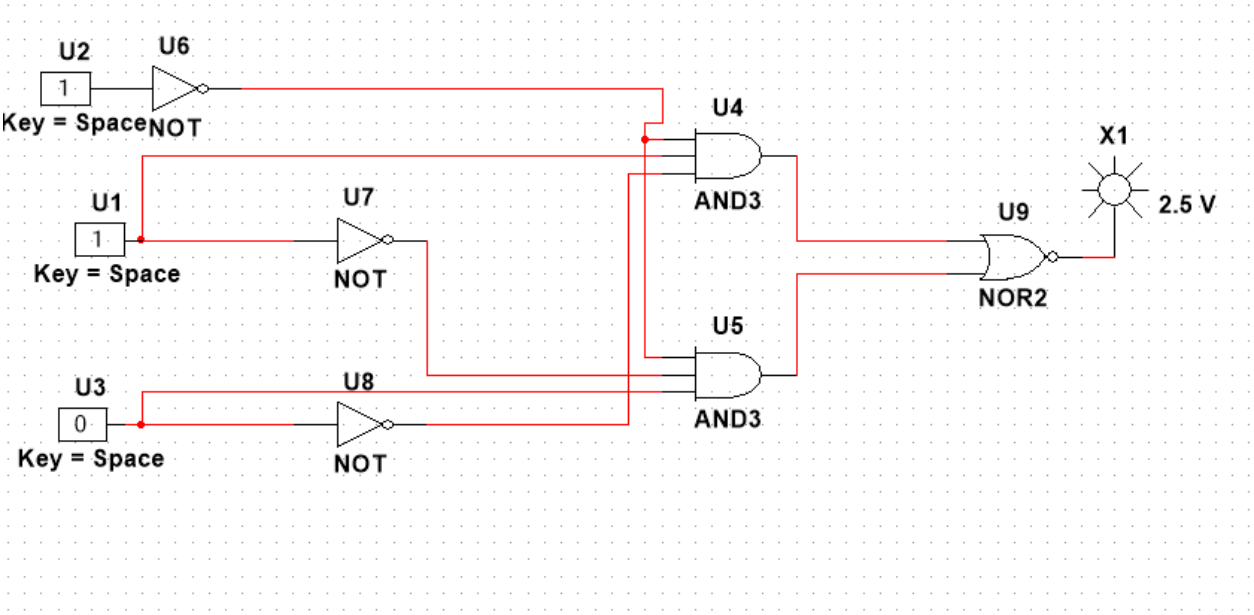
After Simplify = A+B'C+CB

Truth table

A	B	C	B'	C'	B'C	CB	A+B'C+CB
0	0	0	1	1	0	0	0
0	0	1	1	0	1	0	1
0	1	0	0	1	0	0	0
0	1	1	0	0	0	1	1
1	0	0	1	1	0	0	1
1	0	1	1	0	1	0	1
1	1	0	0	1	0	0	1
1	1	1	0	0	0	1	1

Task 3: (In Lab Task):

1. **Use Multisim simulator to simulate the given logic function and to test its operation.**



2. **Use advanced input methods to simulate the given logic function and test its operation in each Case using Multisim simulator.**