Technical Report

problem declaration:

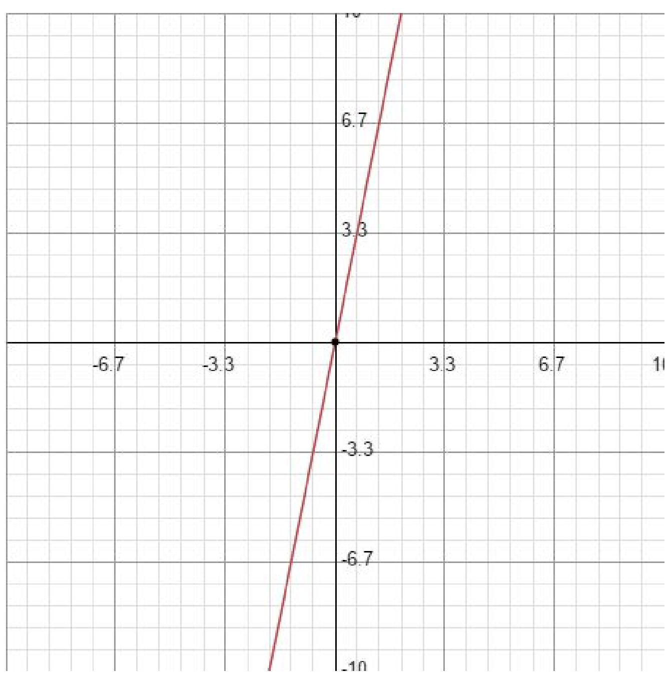
We are going to design a circuit to receive a 4 bit digit number with 4 switches in order to calculate the amount of it’s integral.

$$\int 5x \, dx$$

output will display in 7-segments.

solution :

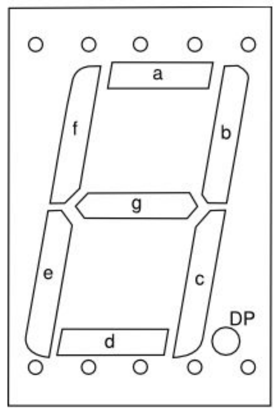
since a 4 bit number in the Decimal system covers a number in range of 0 to 15. According to the definition of integrals, we know that in a function like: $f_{(x)}=5x$ the answer is the between the $f_{(x)}$ and the x-axis. So it should be between x=0 to x=A (A: is the input value to calculate)



$$\int 5x \, dx = 5\,(x^2/2) \Rightarrow 5\,(A^2/2)$$

We are going to use four 7-segments. So our output will look like xxx.x in the decimal system. The 8th pin of our third seven segment will turn on as DP-point to show the float number.

the 7-segment with common anode display will turn on by 1(TRUE) inputs.



so it will display the numbers according to the below chart:

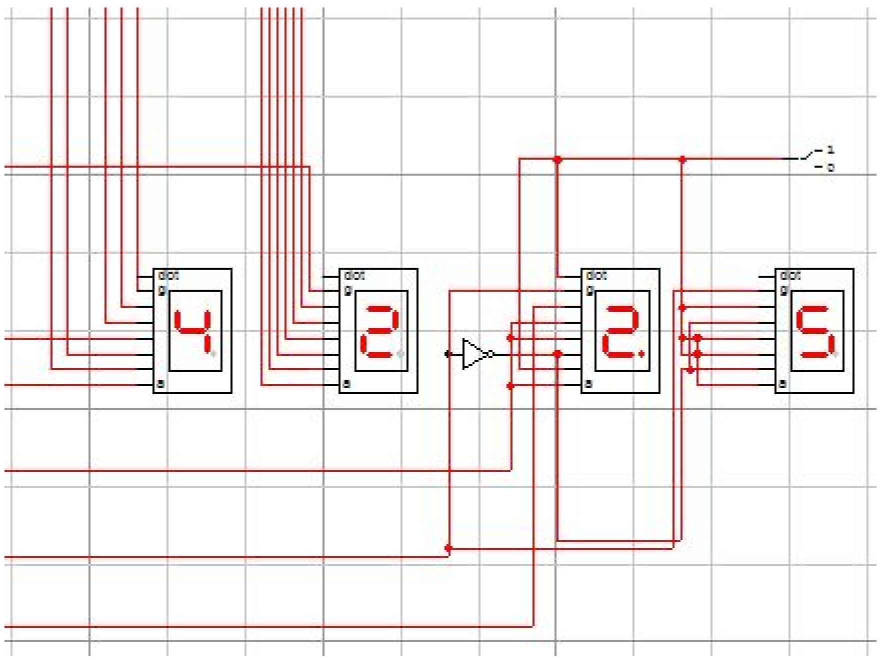
Digit number	a	b	c	d	e	f	g
0	1	1	1	1	1	1	0
1	0	1	1	0	0	0	0
2	1	1	0	1	1	0	1
3	1	1	1	1	0	0	1
4	0	1	1	0	0	1	1
5	1	0	1	1	0	1	1
6	1	0	1	1	1	1	1
7	1	1	1	0	0	0	0
8	1	1	1	1	1	1	1
9	1	1	1	0	0	1	1

eventually we will have 4 seven segments and 4 tables for each of them to show the output:

the next table demonstrates each potential output for its input for the numbers between 0 to 15(solution for numbers between these 16 digits.)

inputs					O0							O1							O2							O3						
dec	a	b	c	d	A0	B0	C0	D0	E0	F0	G0	A1	B1	C1	D1	E1	F1	G1	A2	B2	C2	D2	E2	F2	G2	A3	B3	C3	D3	E3	F3	G3
0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0
1	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
2	0	0	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	1	1	1	1	1	1	0
3	0	0	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1
4	0	1	0	0	1	1	1	1	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
5	0	1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	1	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
7	0	1	1	1	0	1	1	0	0	0	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1
8	1	0	0	0	0	1	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
9	1	0	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
10	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
11	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
12	1	1	0	0	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
13	1	1	0	1	0	1	1	0	0	1	1	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1
14	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
15	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1

SOP form for karnaugh tables will calculate and the functions will deploy in the circuit.



	00	01	11	10
00	1	1	1	1
01	1	1	0	1
11	1	0	1	0
10	0	1	1	1

A_0=a’b’+a’c’+a’d’+cb’+b’d+bc’d’+cda

	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	0	1
10	1	1	1	1

B_0=c’+a’+d’+b’

	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	1
10	1	0	1	0

C_0=a’+b+cd+c’d’

	00	01	11	10
00	1	1	1	1
01	1	1	0	1
11	1	0	1	0
10	0	1	1	1

D_0=a’b’+c’a’+b’c+d’a’+db’+bc’d’+cda

	00	01	11	10
00	1	1	1	1
01	1	1	0	1
11	0	0	0	0
10	0	1	0	1

E_0=a’b’+a’c’+d’a’+cd’b’+c’db’

	00	01	11	10
00	1	1	1	1
01	1	1	0	1
11	0	1	1	1
10	0	0	0	0

$F_0=a'b'+a'c'+d'a'+abc+abd$

	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	1	1	1

$G_0=ab+ac+ad$

	00	01	11	10
00	1	1	1	1
01	0	1	1	1
11	1	1	1	1
10	1	1	1	1

$A_1=a+c+d+a'b'$

	00	01	11	10
00	1	1	1	1
01	1	0	1	1
11	0	1	0	1
10	0	1	1	0

$B_1=a'b'+a'c+a'd'+b'd+cd'b+c'da$

	00	01	11	10
00	1	1	0	1
01	1	1	0	1
11	1	0	1	1
10	1	1	1	1

$C_1=d'+ab'+ac+a'c'$

	00	01	11	10
00	1	1	1	1
01	0	1	1	0
11	1	1	1	0
10	1	1	1	1

$D_1=d+b'd'+ac'$

	00	01	11	10
00	1	1	1	1
01	0	1	1	0
11	1	1	1	0
10	1	1	1	0

$E_1=d+ac'+a'b'$

	00	01	11	10
00	1	1	0	1
01	1	1	0	1
11	1	0	1	1
10	1	1	1	1

$F_1=d'+ab'+a'c'+ac$

	00	01	11	10
00	0	0	1	0
01	1	1	1	1
11	1	1	1	1
10	1	0	0	1

$G_1=b+cda'+ad'$

	00	01	11	10
00	1	1	1	0
01	1	1	1	1
11	1	1	1	1
10	1	1	1	1

$A_2=D_2=E_2=c'+d+a+b$

	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	1
10	1	1	1	1

$B_2=1$

	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	0	0	1
10	1	0	0	1

$C_2=d'$

	00	01	11	10
00	1	0	0	0
01	1	0	0	1
11	1	0	0	1
10	1	0	0	1

$F_2=c'd'+d'a+d'b$

	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

$G_2=d$

	00	01	11	10
00	1	1	1	1
10	1	1	1	1
11	1	1	1	1
10	1	1	1	1

$A_3=C_3=D_3=F_3=1$

	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	0	0	1
10	1	0	0	1

$B_3=E_3=d'$

	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

$G_3=d$

some of the functions are reduced and briefed :

$C_0 = a'+b+(c\oplus d)'$

$E_0=a'b'+a'c'+a'd'+b'(c\oplus d)$

$G_0=a(b+c+d)$

$C_1=d'+ab'+(a\oplus c)' = F_1$

- to reduce a level from the circuit we use not include gates instead of changing the inputs to FALSE.

.cct file is made by Logic work application.(final circuit design)