**Final Project**

**Course Title:**

Digital Logic Design.

**Project Title:**

3 Bit Multiplier using 7-segment display.

**Submitted to:**

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**(A). 3-Bit Multiplier:**

Multiplier: B2, B1, B0.

Multiplicand: A2, A1, A0.

* Firstly, B0 gets multiply with all the bits of A.

(B0.A2, B0.A1, B0.A0).

* Secondly, B1 gets multiply with all the bits of A.

(B1.A2, B1.A1, B1.A0).

* Now, the term B0.A0 (S0) will comes directly in the output.
* For addition of B0.A1 and B1.A0, half adder is used. Its sum (S1) goes directly in the output and its carry will use later in the Full-Adder of next term. We name this carry with c1.
* For addition of B0.A2 and B1.A1, half adder is used. Its sum will add in its third term (B2.A0). Its carry will use later in the half-adder. We name this carry c2.
* The term B1.A2 remains same.
* Now, B2 gets multiply with all the bits of A.

(B2.A2, B2.A1, B2.A0).

* In order to add B2.A0 , c1 and the sum (B0.A2+B1.A1), Full Adder is used. Its sum (S2) goes directly in the output and it’s carry (c3) will use later in Half Adder.
* Another Full-Adder is used to add B1.A2, B2.A1 and c2. Sum and Carry is generated and carry (c4) will add into the next term.
* Further, a Half Adder is used to add sum of previous full adder and c3. Its sum (S3) will comes directly in the output and carry (c5) will add to next Full-Adder.
* We use a final Full-Adder to add B2.A2, c4 and c5. Its sum (S4) and carry (S5) goes directly in the output.

**(B). 6 Bit to BCD Converter**

**Truth Table:**

**A B C D E F a b c d e f g h**

**OUTPUTS**

**INPUTS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 |  | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 |  | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 0 |  | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 1 |  | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 | 0 |  | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 1 | 1 |  | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 |  | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 |  | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 1 | 0 |  | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 |  | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 0 |  | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 | 1 |  | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 1 | 0 |  | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 |  | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 |  | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 1 |  | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 | 0 |  | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 |  | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 |  | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 |  | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 |  | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 1 |  | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 |  | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 1 |  | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 |  | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 |  | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 |  | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 1 |  | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 |  | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 | 1 |  | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 |  | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 | 1 |  | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 0 |  | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 |  | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 | 0 |  | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 |  | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 0 |  | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 1 |  | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 |  | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 1 |  | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 1 | 0 |  | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 |  | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 0 |  | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 |  | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 1 | 0 |  | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 1 |  | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 |  | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 |  | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 0 |  | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 1 |  | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 |  | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |  | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1 | 0 |  | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 | 1 |  | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 | 0 |  | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 |  | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 | 0 |  | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 |  | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 | 0 |  | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 | 1 |  | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 0 |  | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 |  | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |

**K-MAPS:**

As ‘a’ is not true for any value so,

* a=0.

**K-map for b:**

**ABC**

**DEF**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 000 | 001 | 011 | 010 | 100 | 101 | 111 | 110 |
| 000 |  |  |  |  |  |  |  |  |
| 001 |  |  |  |  |  |  |  |  |
| 011 |  |  |  |  |  |  |  |  |
| 010 |  |  |  |  |  |  |  |  |
| 100 |  |  |  |  |  |  |  |  |
| 101 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 111 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 110 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
|  |  |  |  |  |  |  |  |  |

Groups:

(40,41,42,43,44,45,46,47,56,57,58,59,60,61,62,63) =A.C

(48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63) =A. B

* b=AC+AB.

**K-map for c:**

**DEF**

**ABC**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 000 | 001 | 011 | 010 | 100 | 101 | 111 | 110 |
| 000 |  |  |  |  |  |  |  |  |
| 001 |  |  |  |  |  |  |  |  |
| 011 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 010 |  |  |  |  | 1 | 1 | 1 | 1 |
| 100 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 101 |  |  |  |  |  |  |  |  |
| 111 |  |  |  |  | 1 | 1 | 1 | 1 |
| 110 |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

Groups:

(20,21,22,23,28,29,30,31) = A’BD

(24,25,26,27,28,29,30,31) = A’BC

(28,29,30,31,60,61,62,63) = BCD

(32,33,34,35,36,37,38,39) = AB’C’

* c= A’BD+ A’BC+ BCD+ AB’C’.

**K-map for d:**

**ABC**

**DEF**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 000 | 001 | 011 | 010 | 100 | 101 | 111 | 110 |
| 000 |  |  |  |  |  |  |  |  |
| 001 |  |  | 1 | 1 | 1 | 1 | 1 | 1 |
| 011 |  |  |  |  |  |  | 1 | 1 |
| 010 | 1 | 1 | 1 | 1 |  |  |  |  |
| 100 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 101 |  |  |  |  |  |  |  |  |
| 111 | 1 | 1 | 1 | 1 |  |  |  |  |
| 110 |  |  | 1 | 1 | 1 | 1 | 1 | 1 |
|  |  |  |  |  |  |  |  |  |

Groups:

(32,33,34,35,36,37,38,39) = AB’C’

(34,35,38,39,50,51,54,55) =AC’E

(36,37,38,39,52,53,54,55) =AC’D

(10,11,14,15) =A’B’CE

(12,13,14,15) =A’B’CD

(14,15,30,31) =A’CDE

(16,17,18,19) =A’BC’D’

(56,57,58,59) =ABCD’

* d= AB’C’+ AC’E+ AC’D+ A’B’CE+ A’B’CD+ A’CDE+ A’BC’D’+ ABCD’

**K-map for e:**

**ABC**

**DEF**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 000 | 001 | 011 | 010 | 100 | 101 | 111 | 110 |
| 000 |  |  |  |  |  |  |  |  |
| 001 | 1 | 1 |  |  |  |  |  |  |
| 011 |  |  |  |  | 1 | 1 |  |  |
| 010 |  |  | 1 | 1 |  |  |  |  |
| 100 |  |  |  |  |  |  | 1 | 1 |
| 101 |  |  |  |  |  |  |  |  |
| 111 |  |  | 1 | 1 |  |  |  |  |
| 110 | 1 | 1 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

Groups:

(8,9) =A’B’CD’E’

(18,19) =A’BC’D’E

(28,29) =A’BCDE’

(38,39) =AB’C’DE

(48,49) =ABC’D’E

(58,59) =ABCD’E

* e= A’B’CD’E’+ A’BC’D’E+ A’BCDE’+ AB’C’DE+ ABC’D’E+ ABCD’E.

**K-map for f:**

**DEF**

**ABC**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 000 | 001 | 011 | 010 | 100 | 101 | 111 | 110 |
| 000 |  |  |  |  | 1 | 1 | 1 | 1 |
| 001 |  |  |  |  |  |  | 1 | 1 |
| 011 | 1 | 1 | 1 | 1 |  |  |  |  |
| 010 | 1 | 1 |  |  |  |  |  |  |
| 100 |  |  | 1 | 1 | 1 | 1 |  |  |
| 101 |  |  |  |  | 1 | 1 | 1 | 1 |
| 111 | 1 | 1 |  |  |  |  |  |  |
| 110 |  |  |  |  |  |  | 1 | 1 |
|  |  |  |  |  |  |  |  |  |

Groups:

(4,5,6,7) = A’B’C’D

(14,15,46,47) =B’CDE

(16,17,24,25) =A’BD’E

(24,25,26,27) =A’BCD’

(24,25,56,57) =BCD’E’

(36,37,44,45) =AB’DE’

(34,35) =AB’C’D’E

(54,55) =ABC’DE

* f= A’B’C’D+ B’CDE+ A’BD’E+ A’BCD’+ BCD’E’+ AB’DE’+ AB’C’D’E+ ABC’DE.

**K-map for g:**

**DEF**

**ABC**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 000 | 001 | 011 | 010 | 100 | 101 | 111 | 110 |
| 000 |  |  | 1 | 1 |  |  | 1 | 1 |
| 001 |  |  |  |  | 1 | 1 |  |  |
| 011 |  |  | 1 | 1 |  |  |  |  |
| 010 | 1 | 1 |  |  |  |  | 1 | 1 |
| 100 | 1 | 1 |  |  | 1 | 1 |  |  |
| 101 |  |  | 1 | 1 |  |  | 1 | 1 |
| 111 | 1 | 1 |  |  |  |  | 1 | 1 |
| 110 |  |  |  |  | 1 | 1 |  |  |
|  |  |  |  |  |  |  |  |  |

Groups:

(2,3,6,7) =A’B’C’E

(6,7,22,23) =A’C’DE

(32,33,36,37) =AB’C’E’

(36,37,52,53) =AC’DE’

(42,43,46,47) =AB’CE

(46,47,62,63) =ACDE

(12,13) =A’B’CDE’

(16,17) =A’BC’D’E’

(26,27) =A’BCD’E

(56,57) =ABCD’E’

* g= A’B’C’E+ A’C’DE+ AB’C’E’+ AC’DE’+ AB’CE+ ACDE+ A’B’CDE’+ A’BC’D’E’+ A’BCD’E+ ABCD’E’.

Through the table, we can write:

* h=F.

**(C). 7 Segment Display**







