

HARDWARE LAB 2  
Designing BCD-to-seven-segment decoder  
Digital Design: CPEN214

NAME \_\_\_\_\_

A BCD-to-seven-segment decoder is a combinational circuit that converts a decimal digit in BCD to an appropriate code for the selection of segments in a display indicator that uses 8 light-emitting diodes including one for the decimal point (pin 5). The seven outputs of the decoder ( $a, b, c, d, e, f, g$ ) shown in Fig. 1 select the corresponding segments in the display. The pinout diagram for the display indicator is shown in Fig. 2. Each numeric display can be selected to represent the decimal digits (see Table 1.)

For the Lab:

1. Complete the segments truth table for digits 2 through 9.
2. Obtain the simplified Boolean expressions in sum-of-products form for all the segments  $a \rightarrow g$ . The simplified expression for segment  $a$  is provided in Fig. 3. Note that you can use 3-variable K-Map for numbers  $0 \rightarrow 7$  since input  $A$  is always 0.
3. Using logic gates, construct the circuits to realize the logic expressions for the necessary segments whose outputs you will use to display any 3 numbers ( $0 \rightarrow 7$ ). Your circuit should be expandable to display all numbers.
4. For an extra 5 points added to the final exam grade, construct the circuit to display ( $0 \rightarrow 7$ ). For an additional 5 points, connect this circuit to the 3-bit counter output in lab 3.

The write-up (1-2 page report) should include:

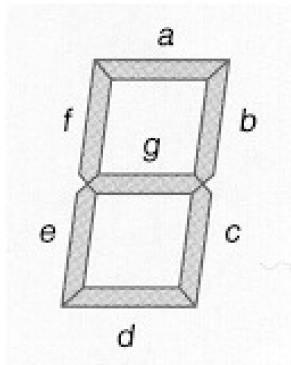
- I. This handout with name.
- II. Completed truth table and K-maps for all segments.
- III. Circuit diagrams for the segments that you will use.

The grading for this lab is as follows:  
(40% report and 60% demo)

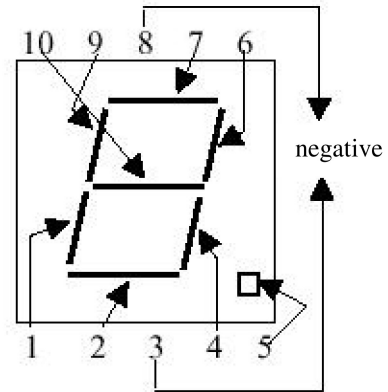
This handout with name.....5%  
Truth table..... .5%  
K-Maps..... 20%  
Circuit diagrams..... 10%

| DIGIT | INPUTS   |          |          |          | OUTPUT<br>(DISPLAY) | OUTPUT (seven segment) |          |          |          |          |          |          |
|-------|----------|----------|----------|----------|---------------------|------------------------|----------|----------|----------|----------|----------|----------|
|       | <i>A</i> | <i>B</i> | <i>C</i> | <i>D</i> |                     | <i>a</i>               | <i>b</i> | <i>c</i> | <i>d</i> | <i>e</i> | <i>f</i> | <i>g</i> |
| 0     | 0        | 0        | 0        | 0        | 0                   | 1                      | 1        | 1        | 1        | 1        | 1        | 0        |
| 1     | 0        | 0        | 0        | 1        | 1                   | 0                      | 1        | 1        | 0        | 0        | 0        | 0        |
| 2     | 0        | 0        | 1        | 0        | 2                   |                        |          |          |          |          |          |          |
| 3     | 0        | 0        | 1        | 1        | 3                   |                        |          |          |          |          |          |          |
| 4     | 0        | 1        | 0        | 0        | 4                   |                        |          |          |          |          |          |          |
| 5     | 0        | 1        | 0        | 1        | 5                   |                        |          |          |          |          |          |          |
| 6     | 0        | 1        | 1        | 0        | 6                   |                        |          |          |          |          |          |          |
| 7     | 0        | 1        | 1        | 1        | 7                   |                        |          |          |          |          |          |          |
| 8     | 1        | 0        | 0        | 0        | 8                   |                        |          |          |          |          |          |          |
| 9     | 1        | 0        | 0        | 1        | 9                   |                        |          |          |          |          |          |          |
| X     | X        | X        | X        | X        | -                   | X                      | X        | X        | X        | X        | X        | X        |
| X     | X        | X        | X        | X        | -                   | X                      | X        | X        | X        | X        | X        | X        |
| X     | X        | X        | X        | X        | -                   | X                      | X        | X        | X        | X        | X        | X        |
| X     | X        | X        | X        | X        | -                   | X                      | X        | X        | X        | X        | X        | X        |
| X     | X        | X        | X        | X        | -                   | X                      | X        | X        | X        | X        | X        | X        |
| X     | X        | X        | X        | X        | -                   | X                      | X        | X        | X        | X        | X        | X        |

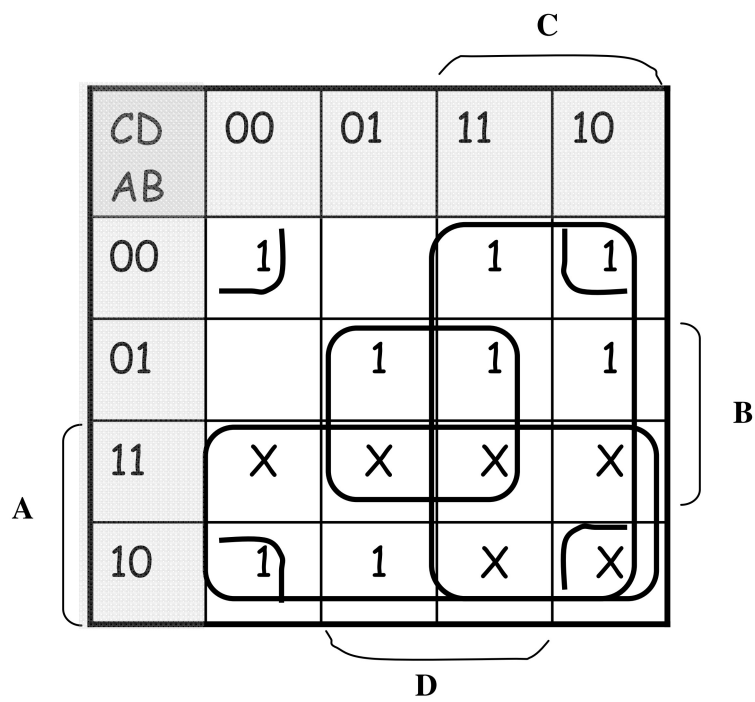
**Table 1:** Truth table for BCD-to-seven-segment decoder.



**Fig. 1:** Segment designation.



**Fig. 2:** Display indicator pinout.



$$a = A + C + BD + B'D'$$

**Fig. 3:** K-map for segment *a* using 4-variable K-map.