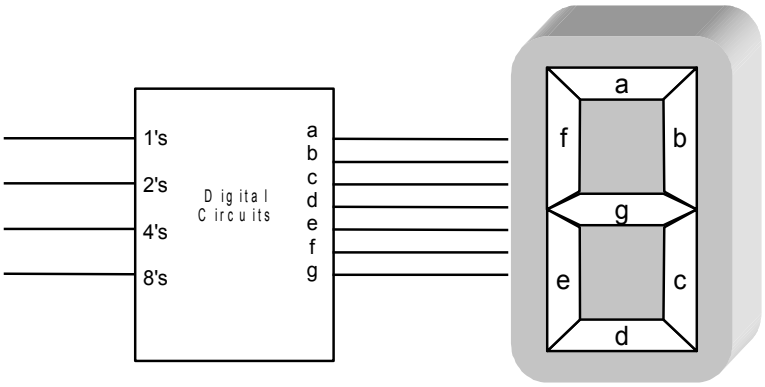
CETT1425 Lab **Name** _____
The Seven-Segment Decoder **Date** _____

- Computers and other binary digital equipment use the binary number system internally because the circuitry to manipulate binary numbers is simple, fast, and inexpensive. Human beings, however, are predisposed to the decimal number system. When the computer must show a number to a human--the machine/man interface--conversion from binary to a decimal display is usually necessary. One type of display used for this purpose is called a *7-segment display*. It consists of seven "optically active" segments arranged as shown here.



- To display the number "1" segments b and c (or segments f and e) would be turned on. To display a "2" segments a, b, g, e, and d would be activated.
- You must design the digital circuits to go into the box which will allow the binary codes to light the proper segments to make the shape of the decimal digit which corresponds to the input code.

- Your first task is to write the truth-table for this *Binary To 7-Segment Converter*. Note that this converter must have four binary inputs (so that a count between 0 and F can be input) and seven outputs--one for each segment to be lighted. Fill in the entire truth-table shown here.
- There are a few digits and hex symbols which have several possible forms. The number 6 and the hex letter "B" could cause problems if they are not carefully considered.
- The table shows lines in for all the counts up to 1111_2 **but you only have to design the circuit for the counts from 000 through 111**. Your display will only show these counts in order to simplify the circuit. Your converter will be an *octal to 7-segment converter.*
- As a BONUS you may include the P input and decode counts for a decimal (0 through 9) or hex (0 through F) display. It will make the circuit much more complex--be prepared for lots of extra work!

4 INPUTS				HEXADECIMAL	**7** OUTPUTS						
P	Q	R	S		a	b	c	d	e	f	g
0	0	0	0	0							
				1							
				2							
				3							
				4							
				5							
				6							
				7							
				8							
				9							
				A							
				b							
				C							
				d							
				E							
1	1	1	1	F							

- Keep in mind that you are not building one circuit, but **7 circuits, one for each lighted segment.**
- The next step is to write the Boolean equation for each segment. Write the seven boolean equations below in *Sum-of-Products (minterm)* form. Write **only for the unshaded portion** of the truth table using Q, R, and S. **Do not include the P term unless you intend to do the BONUS.**
- Note the you may write the equations for the "0"s in the table, if that appears simpler. If you are writing for the zeros, indicate that by showing the segment letter inverted. This can be re-inverted if desired.

a =

b =

c =

d =

e =

f =

g =

- Use Boolean Algebra to reduce the equation for **only segment a** to a simpler, easier-to-build form.

a =

- ***You have three choices for simplifying the remaining equations, b through g:***

  (1) You may design and build your circuits without reducing the equations at all. This will involve a LOT of wires and circuits, but will work.

  (2) You may reduce all of the equations to simpler circuits using Boolean Algebra. Don't even think about this approach unless you are a fair hand at algebra.

  (3) You can read your text and learn how to do Karnaugh mapping. I'd suggest learning how to do Karnaugh mapping. It is not hard, and does the best job of making circuit equations simpler.

  Use Karnaugh mapping (or your choice of method) to reduce the equation for each of the remaining segments.

- Karnaugh map (or Boolean Algebra) for segment a:

  NOTE! On page 134 in the text, the K-map example has an error!

a = _____

- Karnaugh map (or Boolean Algebra) for segment b:

b = _____

- Karnaugh map (or Boolean Algebra) for segment c:

c = _____

- Karnaugh map (or Boolean Algebra) for segment d:

d = _____

- Karnaugh map (or Boolean Algebra) for segment e:

e = _____

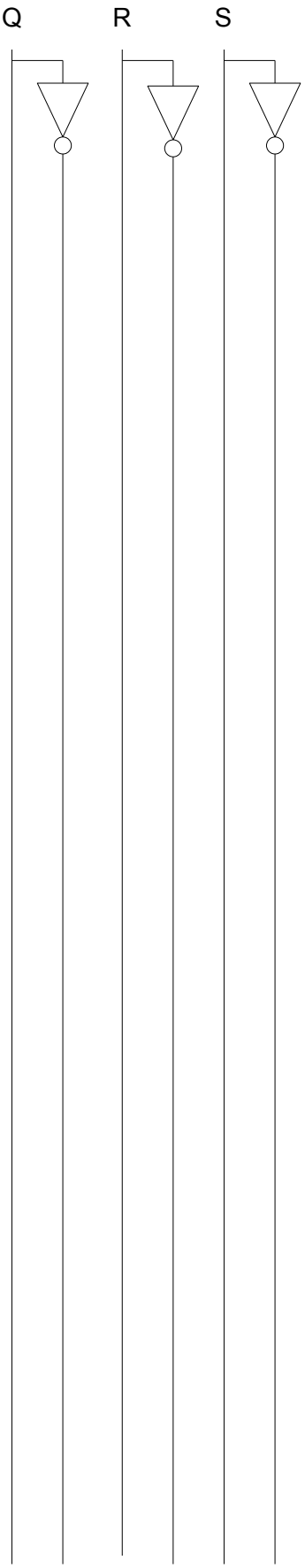
- Karnaugh map (or Boolean Algebra) for segment f:

f = _____

- Karnaugh map (or Boolean Algebra) for segment g:

g = _____

- After comparing your equations with others in the lab, draw the circuit for each of the segments

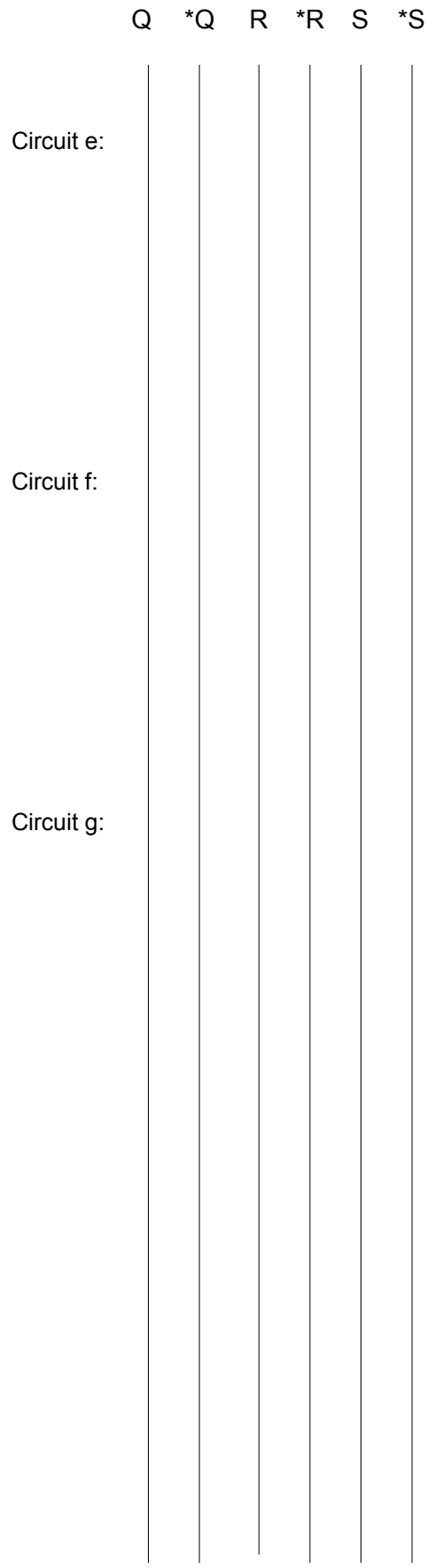


Circuit a:

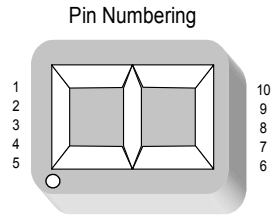
Circuit b:

Circuit c:

Circuit d:


Q
*Q
R
*R
S
*S
Circuit e:
Circuit f:
Circuit g:

- The pin connections for the 7-segment display used in lab are shown in the table. Sketch the actual diode connections below.



PIN #	SEGMENT
1	e
2	d
3	common
4	c
5	dp
6	b
7	a
8	common
9	f
10	g