BM20A8800 Discrete Models and Methods 3op

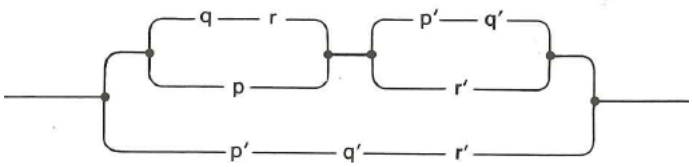
Exercise 2 / Week 4

1. Below is a simplified circuit diagram of a logic circuit. *(Note: "simplified" regarding notation; see lecture 3, slide 6. Negations are marked as apostrophes, so p' = "not p".)*

a) Formulate the logic function F(p,q,r) of this circuit using shorthand notation.

b) This logic function (and hence the circuit) is a bit complicated; the same function could be executed also in an easier way. Simplify the logic function using laws of Boolean algebra.

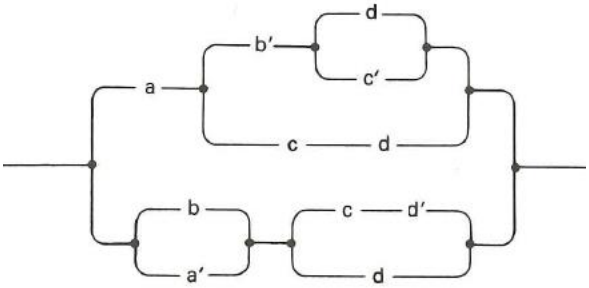
c) Draw the circuit diagram of this simplified function.



2. Below is a simplified circuit diagram of a logic circuit.

a) Formulate the logic function F(a,b,c,d) of this circuit and present it in SOP-form. *(Hint: this can be done by expanding the brackets. Note: you don't need to simplify the function yet - as long as it is in SOP-form, it is ok; the terms don't need to be minterms.)*

b) Based on the SOP-form, construct the truth table of this function.



3. Let's continue examining the previous problem.

a) There should be more 1s than 0s in the truth table. Identify the maxterms and present the logic function in POS-form. *(Note: You don't need to simplify this in order to get points.)*

b) Unsimplified SOP-form using minterms would be quite long, so let's not bother to write that. Instead perform a SOP-form simplification for the function using Karnaugh map.

c) Draw a circuit diagram of the resulting (hopefully simpler) function.

4. On the right there is a truth table of a logic function F(A,B,C).

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

a) Construct a Karnaugh map and define the simplest possible SOP-form for the function.

b) Construct a Karnaugh map and define the simplest possible POS-form for the function.

c) The engineer that has constructed the truth table finds out that the variable combination ABC is not realistic in any case and hence its truth value is of no importance. What are now the simplest possible SOP- and POS-forms?

5. On the right we can see a truth table of a four-variable logic function.

A	B	C	D	F
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

a) Define the simplest possible SOP-form of this function using Karnaugh map.

b) Draw the circuit diagram of this simplified function.

6. Finnish company Fazer produces popular Domino-cookies in their factory. The cookies are made on a machine that fills the space between cookie halves with vanilla filling, presses the halves together and wraps ready cookies in plastic wrap for packaging purposes. The machine is used by two operators.

Operator 1 is allowed to have a coffee break a) when the machine has plastic wrap but no cookie halves or b) when the machine has cookie halves but no vanilla filling.

Operator 2 is allowed to have a coffee break a) when the machine has plastic wrap but no vanilla filling, or b) when the machine has vanilla filling but no cookie halves.

Both operators know their right very well and never miss a coffee break when they are allowed to have one. The factory manager wants to have his room equipped with an indicator light which lits up every time when both operators are having a coffee break at the same time. Design the simplest possible logic circuit for controlling the indicator light and draw its circuit diagram.

Hint: Start by constructing a truth table (use variables c = "cookie halves", p = "plastic wrap" and v = "vanilla filling"). Then perform the simplification either by Boolean algebra or using a Karnaugh map.

Answers/hints to selected problems:

1. b) (p + q')r' *3. b) F = d + a'c + bc + ab'c'* *6. Simplified SOP-form has 2 terms.*