Problem Sheet: Digital Circuits

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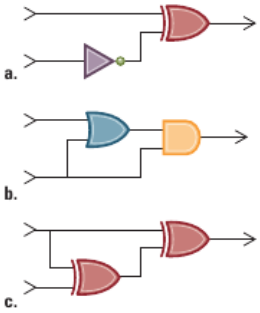
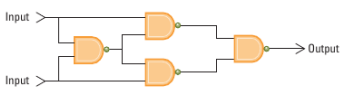
1. Define the truth table for the following circuits:



(e)



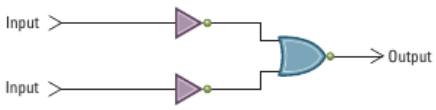
2. (a) Give the truth table for the counterpart *nor* of the *nand* gate (a better name for *nor* would be *negmax*).

   (b) Implement *nor* using the standard gates (*not*, *and*, *or*).

   (c) Implement *nor* using only *nand* gates.

   (d) Implement the standard gates using only *nor* gates.

   (e) *Nor* gates are represented in the same way as *or* gates, except for having a circle at their output. Give the truth table for the following circuit:



3. Derive the simplest possible sum-of-terms expressions for each of the following functions

   (a) $f : \mathbb{B}^5 \to \mathbb{B}$, $f(x) = 1$ if x is the binary representation of a number between 20 and 30, and 0 otherwise

   (b) $f : \mathbb{B}^3 \to \mathbb{B}$, $f(x) = 1$ if there are more 1s than 0s in x

   (c) same as the previous one, but for $f : \mathbb{B}^4 \to \mathbb{B}$

   (d) $f : \mathbb{B}^4 \to \mathbb{B}$, $f(x) = 0$ if the number represented by x is even

   (e) $f : \mathbb{B}^4 \to \mathbb{B}$, $f(x_0, x_1, x_2, x_3) = 1$ if the number represented by x_0x_1 is smaller than x_2x_3.

   (f) same as the previous one, but with “smaller than equal”.

4. Construct Karnaugh maps for each of the following expressions, and derive simplified versions:

   (a) $w\overline{x}\overline{y} + wx\overline{y} + \overline{w}xy + \overline{w}x\overline{y} + wxy + w\overline{x}y$

   (b) $wx\overline{y} + \overline{w}x\overline{y} + w\overline{x}y + \overline{w}\overline{x}y$

   (c) $x\overline{y} + \overline{w}\overline{y} + \overline{w}x\overline{y} + \overline{w}xy + \overline{w}x\overline{y}$

   (d) $\overline{w}xy\overline{z} + w\overline{x}y\overline{z} + \overline{w}x\overline{y}z + w\overline{x}\overline{y}z + wxyz + \overline{w}xyz + wx\overline{y}z + \overline{w}x\overline{y}z$

References

- Brookshear, Brylow “An Overview of Computer Science”, 13th Ed.
- Lee “From Hardware to Software”, 1982