THE UNIVERSAL PROPERTY OF NAND AND NOR GATES

1- The NAND Gate as a Universal Logic Element

The NAND gate is a universal gate because it can be used to produce the NOT, the AND, the OR, and the NOR functions. An inverter can be made from a NAND gate by connecting all of the inputs together and creating, in effect, a single input, as shown in Fig.(6-8)(a) for a 2-input gate. An AND function can be generated by the use of NAND gates alone, as shown in Fig.(6-8)(b). An OR function can be produced with only NAND gates, as illustrated in part (c). Finally. a NOR function is produced as shown in part (d).

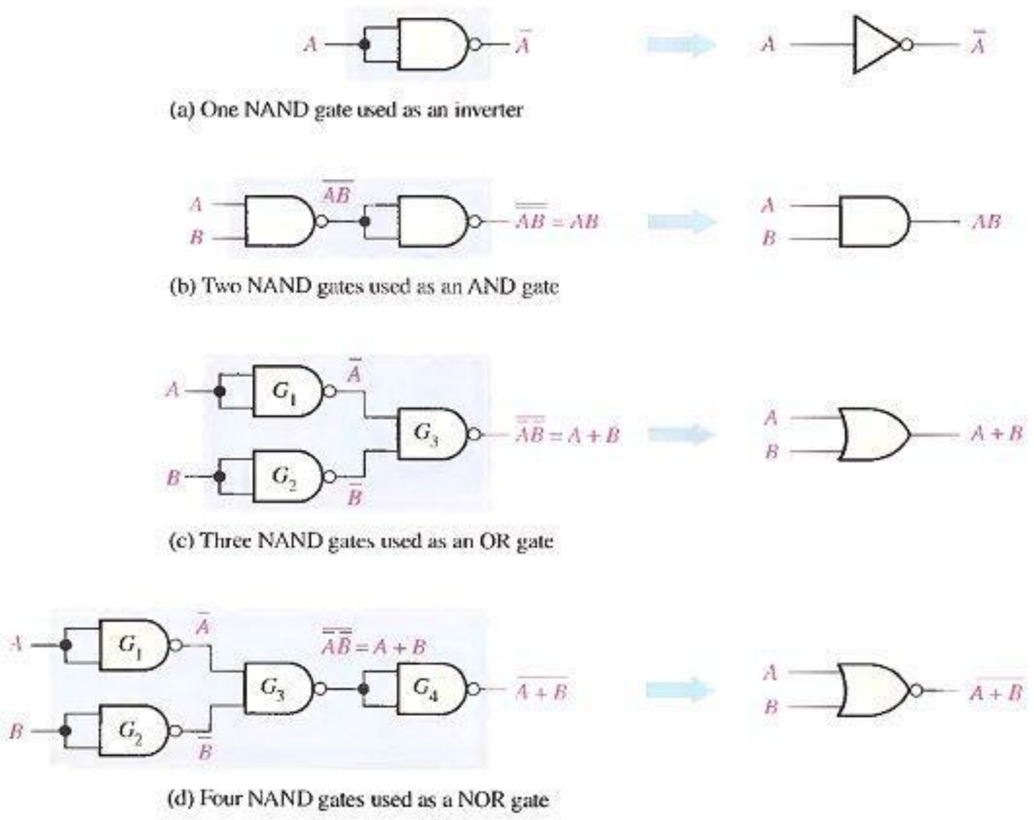


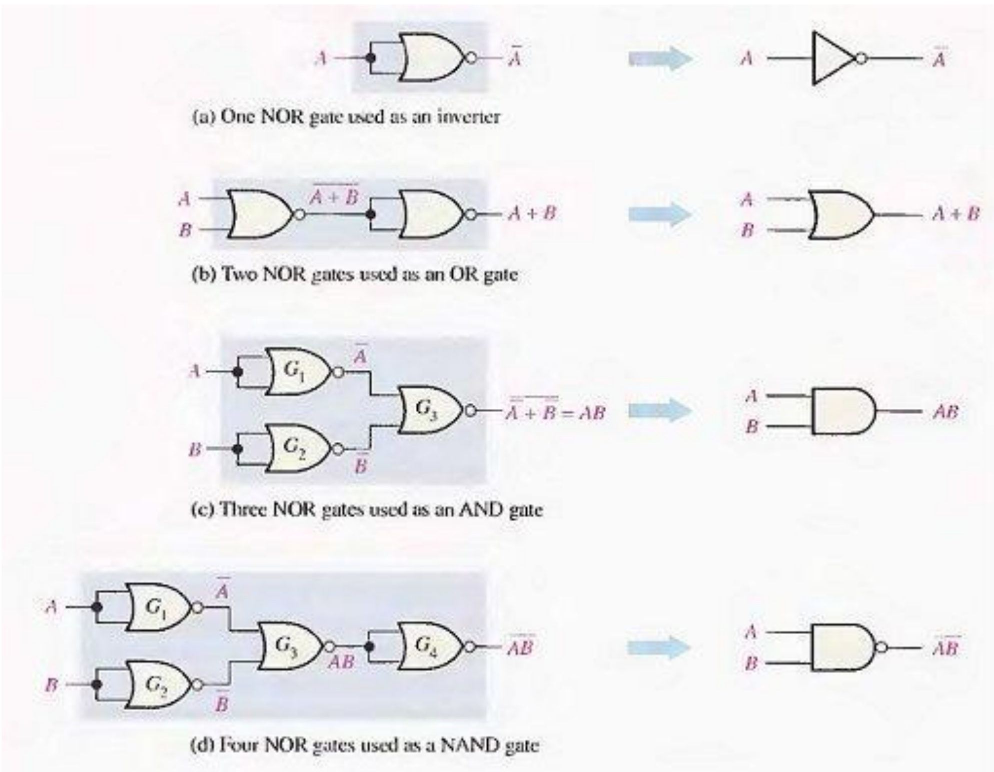
Fig.(6-9)

2- The NOR Gate as a Universal Logic Element

Like the NAND gate, the NOR gate can be used to produce the NOT, AND. OR and NAND functions. A NOT circuit, or inverter, can be made from a NOR gate by connecting all of the inputs together to effectively create a single input, as shown in Fig.(6-10)(a) with a 2-input example. Also, an OR gate can be produced from NOR gates, as illustrated in Fig.(6-10)(b). An AND gate can be constructed by the use of NOR gates, as shown in Fig.(6-10)(c). In this case the NOR gates G 1 and G 2 are used as inverters, and the final output is derived by the use of DeMorgan's theorem as follows:

$$X=A+B=AB$$

Fig.(6-10)(d) shows how NOR gates are used t0 form a NAND function.



(a) One NOR gate used as an inverter
(b) Two NOR gates used as an OR gate
(c) Three NOR gates used as an AND gate
(d) Four NOR gates used as a NAND gate

Fig.(6-10)

Example

1. Use NAND gates to implement each expression:
   (a) $X = \overline{A} + B$ (b) $X = A\overline{B}$
2. Use NOR gates to implement each expression:
   (a) $X = \overline{A} + B$ (b) $X = A\overline{B}$

Example

1- Write the output expression for each circuit as it appears in Fig.(6-11) and then change each circuit to an equivalent AND-OR configuration.

2- Develop the truth table for circuit in Fig.(6-11)(a-b).

3- Show that an exclusive-NOR circuit produces a POS output.