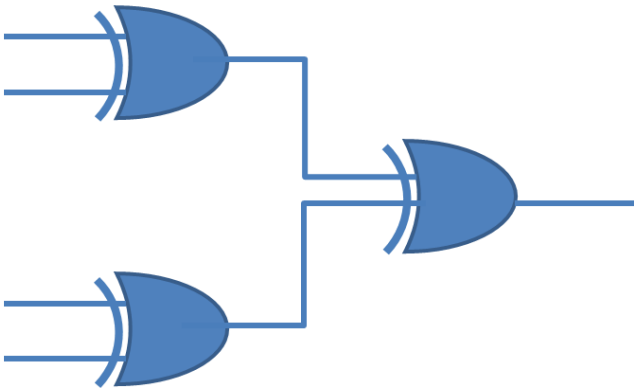
1. Design a circuit using gates (AND, OR, NOT, and XOR) to carry out the **parity check** of 4 bits so that if there are even number of 1s in the 4 bits, the output is 0; and if there are odd number of 1s, the output is 1. Explain your idea. (25%)
(HINT: think about 2 bits parity check problem first.)



2. Suppose an image, as shown in the right, is represented by the bitmap 0000 0001 0011 0111 1111, which uses 20 bits. Can you think a way to compress the image losslessly? How many bits of your compressed image?

3. The CD music is sampled at the rate of 44.1 kHz, and is represented by 16 bits per sampling. (25%)
(a) How many **Megabytes** are needed to store an 80 minutes song? Express your calculation and round your answer to an integer.
(b) If you take a blank CD (CD-R or CD-RW), you will find that its capacity is 700MB for 80 minutes audio. Comparing your answer in 3(a) to it, you shall notice that the required storage is much more than the data itself. (That means your answer in 3(a) should be less than 700M.) In fact, the extra storage is used for **error correction**. Suppose the CD audio uses 14-bit error correction code for 8-bit data, and each 14-bit pattern differs from other 14-bit patterns for at least **five** bits. How many error bits per 14 bits can be corrected? And how many error bits can be detected?

(a) 16 bits/sample * 44100 sample/sec
= 16 * 44100 bit/sec
=88200 bytes/sec

88200 bytes/sec * 80 * 60 sec
=423360000 bytes
=404 MB

(b) 2 ∵至少 5 bits 不同，若 error bits 在 2 bits 內可被更正，3 bits 以上就會判斷錯誤； 4 ∵至少 5 bits 不同，若 4 bits 內可得知有錯誤，5 bits 全錯就會無法判斷

4. One way to transmit data over traditional telephone systems is to convert the bit patterns into sound, transfer the sound over the telephone lines, and then convert the sound back into bit patterns. Such techniques are limited to transfer rates of 57.6K**bps.** (25%)

(a) Suppose we want to have video conference over telephone lines. If the video needs be played at least 20 frames per second, what should be the average data size per frame of the video to achieve this goal? Explain how you calculate it and express your answer in **bytes**.

(b) Suppose we want to transfer an image over the telephone lines. The image has 768×768 pixels and each pixel uses 1 byte to represent the color.

Suppose an image compression technique, which has compression ratio 32:1, is used. For how long this transmission can be done? Write your answer in **seconds**.

(a) 57.6 Kbps
= 57.6 * 1000 / 8 bytes
=7200 bytes/sec

7200 bytes /sec / 20
=360 bytes

(b) 768 * 768 / 32 bits
=18432 bytes

18432 bytes / 7200 bytes/sec
≒2.56