Boolean Logic Problems

Using Crocodile Physics, design and test circuits which will solve each of the following problems. Submit your solutions on paper. Draw each circuit neatly, with all inputs, outputs and all gates labeled. Include a truth table for the circuit and a written explanation of how each circuit works. You may discuss these problems with your classmate, but all diagrams must be original, and all explanations must be in your own words.

1. A BCD code is being transmitted to a remote receiver. The data bits are D, C, B, and A, with D representing the most significant bit (MSB). The receiver includes a BCD code error detector which examines each 4-bit code to see if it is a valid BCD number (0-9). Design a circuit which produces a high output whenever the 4-bit code is greater than 1001.

2. A parity detector is often used to check for errors which may corrupt binary data during transmission. One bit of data is added to each byte or word for this purpose. For even parity, the parity bit is either a 0 or a 1, chosen to make the bits add up to an even number. For odd parity, the parity bit is selected so that the sum of the individual bits is an odd number. Several exclusive OR gates can be connected to create an odd parity detector. Design a circuit which uses XOR gates to produce a high output only when one or three inputs are high.

3. In computers it is often necessary to control the sending and receiving of data to prevent device conflicts and data losses. Serial data is sent one bit at a time, as a series of pulses on a single line. An external modem is connected to data line *x*. To signal that it is ready to receive data it changes the state of control line B from high to low. The serial interface chip has data ready to send connected to line A. Design a circuit which will ensure that line *x* will remain low while B is high, and transmit the data from A when B is low.

4. In binary arithmetic, 0 + 0 = 00, 0 + 1 = 01, 1 + 0 =01 and 1 + 1 = 10. Design a circuit with two inputs and two outputs which adds two bits. (This circuit is known as the half-adder.)

5. A digital lock has three inputs A_2, A_1, A_0 (binary 0 to 8). The lock circuit must produce a high output to open the door only when the three inputs match the three digits stored in memory (B_2, B_1, B_0). Design a circuit which meets these requirements. When you have perfected that circuit, extend it to handle 4 bit numbers.