1. There are two **16 bit 2's complement numbers** in memory addresses **$B000-$B001 (NR1)** and **$B002-$B003 (NR2)**:

   - If the number in memory address **$B004** is **greater than** the **value $0A**, NR2 will be added to NR1 and the result (**NR1+NR2**) will be written into the memory addresses **$B00B-$B00D**.

   - If the number in memory address **$B004** is **less than or equal** to the **value $0A**, NR2 will be subtracted from NR1 and the result (**NR1-NR2**) will be written into the memory addresses **$B00B-$B00D**.

   Write an assembly program which fulfills these calculations. Write addition and subtraction operations as **subroutines**.

   NOTE: DON'T USE 16-bit addition and subtraction instructions of the generic CPU when you solve this question! However, you are allowed to use 8-bit addition and subtraction instructions.

2. The address bus of the CPU is 16-bits and the data bus is 8-bits.

   - Place **three 8K x 8 R/W** memory chips **starting from the address $0000**.

   - Consecutively place **8K x 8 read-only** memory chips starting from the address **$C000**. The total capacity of the read-only memory chips will be **16K**.

   - Connect a **PIA** whose main address is **$A0E0** and an **ACIA** whose main address is **$A0C0**.

   Draw the hardware design which shows all the connections to the CPU (i.e., data/address busses, address decoder for PIA, ASIA and memory chips, ...etc). Don't forget to write-down necessary explanations behind your design!

3. A microprocessor-based competition system will be designed by using following components:

   - A 7-segment display

   - A button for competitor

   - A button for presenter

   Presenter asks a question and then presses his/her button to start timing. At this time, 7-segment display starts counting from 0 and the displayed number increases every 1 second. The timing stops when the competitor presses his/her button. If the timing exceeds 9 seconds, then all the LEDs on the 7-segment display light for 1 second and then fade out.

   - Draw the necessary hardware including 7-segment display and buttons.

   - Write an assembly program which solves the described problem.

   - The assembly program must be designed so that an **interrupt** is generated when the presenter or competitor presses his/her button.

   - The clock frequency of the CPU is 1 MHz.