# objective:

* Execute instructions to create delays using subroutines.
* Perform communication with shift registers.

# references:

* Lab manual chapter 1-2.

# EXPERIMENT 1:

1. Use the following program:

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| .include "m324PAdef.inc"  .org 00  ldi r16,0x01  out DDRA, r16  start:  sbi PORTA,PINA0  cbi PORTA, PINA0  rjmp start |

Connect PA0 to a measurement channel on the TEST STATION and measure pulse forms using an oscilloscope.

# EXPERIMENT 2:

1. Write a subroutine Delay1ms and use it to write a program to generate a 1KHz square wave on PA0.
2. Use this subroutine to write subroutines Delay10ms, Delay100ms, and Delay1s.
3. Use the Delay1s subroutine to write a program to blink/turn off an LED connected to PA0.

# EXPERIMENT 3:

1. Connect the necessary signals from an AVR port to the control signals of the shift register on header J13. Connect the output of the shift register to a LED bar.
2. Using the sample programs from the experiment guide, write a program to create a gradually lit LED effect from left to right, then gradually turn them off from left to right after every 500ms.

# EXPERIMENT 1:

1. Answer the following questions:
   1. Capture a pulse waveform on PA0.
   2. What is the frequency, duration of the high signal, and duration of the low signal?
   3. Explain the measured results.

# EXPERIMENT 2:

1. Answer the following questions:
   1. How to calculate the number of machine cycles needed to execute the Delay1ms subroutine. Present a simulation image.
   2. Image of a 1KHz square wave on PA0.
   3. What is the error?
2. Source code for 2.c with comments.

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# EXPERIMENT 3:

1. Answer the following questions:
   1. Describe the connections on the experimental kit.
   2. According to the datasheet of 74HC595, what is the highest clock frequency it can operate at?
   3. How do you expand the display to 16 LEDs?
2. Source code with comments.

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