In this lab, you will be learning about Serial Peripheral Interface (SPI), which is a serial communication protocol. Refer to Prof. Dinesh Sharma's slides and notes on SPI given here-
`https://ee337.github.io/dks.html#serial-io`

Use the given `main.c`, `spi.c`, `mcp3008.h` and `lcd.h` in the `https://ee337.github.io/2023/downloads/lab9_spi.zip` zip file to complete this lab. **Make sure that all the DIP switches are OFF.**

1. [10 points] In the first part, you need to use the serial port interface (SPI) to interface an analog-to-digital converter (ADC) MCP3008 with the 8051 micro-controller. The MCP3008 is part of the lab kit. Use this setup to measure the input given from a potentiometer.

   i) The micro-controller is to be configured for serial communication with the ADC MCP3008. Complete the function `spi_init` in `spi.c` to configure the SPI so that the micro-controller is the master and the ADC is the slave.

   ii) Test the ADC setup using a potential divider circuit (series of resistors provided in the kit can be connected between supply and ground terminals) as shown in Figure 1. By varying the point at which the output is taken, voltages ranging from 0 to 3.3 V can be obtained as output.

   iii) This output is connected to `CH4` of the ADC. By compiling the project and running the code on the Pt-51 kit, the measured output voltage will be displayed on the LCD in the format shown.
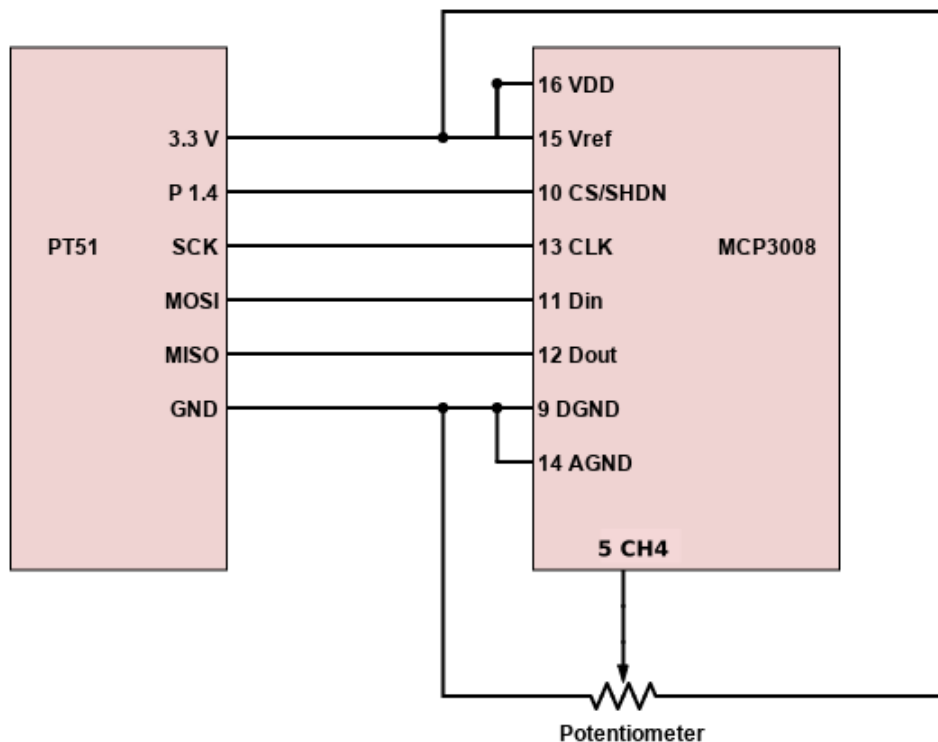
   ```
   Volt : 03229 mV
   ```


Figure 1: Pt51 interfacing with Potentiometer and ADC

2. [10 points] In the second part, you will use the same setup to measure the input given from arbitrary function generator (AFG).

   i) Configure the function generator to provide a sinusoidal waveform of some frequency less than 5 Hz and amplitude 0 V to 3 V.

   ii) Make the connections as shown in Figure 2. Note that the output of the AFG is connected to CH4 of the ADC.

   iii) By compiling the project and running the code on the Pt-51 kit, the measured output voltage will be displayed on the LCD in the same format.
   Observe that the displayed voltages represent a sinusoidal signal. You can see values ranging from 0 mV to 3003 mV continuously varying.
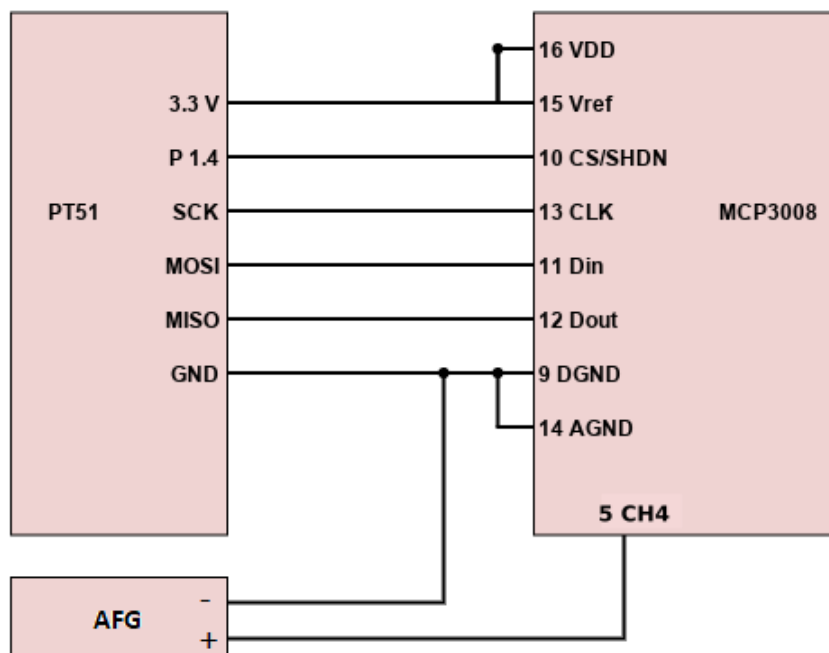

Figure 2: Pt51 interfacing with AFG and ADC

TA Checkpoints

1. Verify that the student can demonstrate the SPI setup to measure the voltage across the potentiometer and display it on the LCD.

2. Verify that the student can demonstrate the SPI setup to measure the sine wave generated by the AFG and display it on the LCD.

3. Make sure that the content on LCD is displayed in the specified format.