LED circuit & GPIO test

NOTE:
- **Be sure to take off your watches, rings, and any metal accessories before practice.**
- **When power is ON, changing wiring or inserting & removing components to the breadboard is strongly prohibited.**
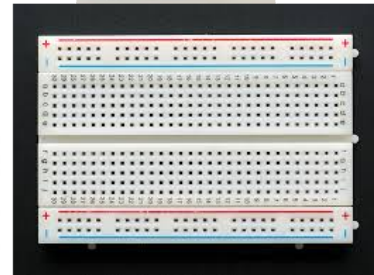
1. Experimental setup.

SSH connection over wired LAN (not wireless!)

Please bring your own nipper if possible.

You will be given this GPIO test kit.

● GPIO (General Purpose Input/Output) pin map

Alternate Function		Pin		Pin		Alternate Function
	3.3V PWR	1		2	5V PWR	
I2C1 SDA	GPIO 2	3		4	5V PWR	
I2C1 SCL	GPIO 3	5		6	GND	
	GPIO 4	7		8	UART0 TX	
	GND	9		10	UART0 RX	
	GPIO 17	11		12	GPIO 18	
	GPIO 27	13		14	GND	
	GPIO 22	15		16	GPIO 23	
	3.3V PWR	17		18	GPIO 24	
SPI0 MOSI	GPIO 10	19		20	GND	
SPI0 MISO	GPIO 9	21		22	GPIO 25	
SPI0 SCLK	GPIO 11	23		24	GPIO 8	SPI0 CS0
	GND	25		26	GPIO 7	SPI0 CS1
	Reserved	27		28	Reserved	
	GPIO 5	29		30	GND	
	GPIO 6	31		32	GPIO 12	
	GPIO 13	33		34	GND	
SPI1 MISO	GPIO 19	35		36	GPIO 16	SPI1 CS0
	GPIO 26	37		38	GPIO 20	SPI1 MOSI
	GND	39		40	GPIO 21	SPI1 SCLK

2. How to use breadboard?

- A breadboard is used to build and test circuits quickly before finalizing any circuit design. The breadboard has many holes into which circuit components like ICs and resistors can be inserted. A typical breadboard is shown below:
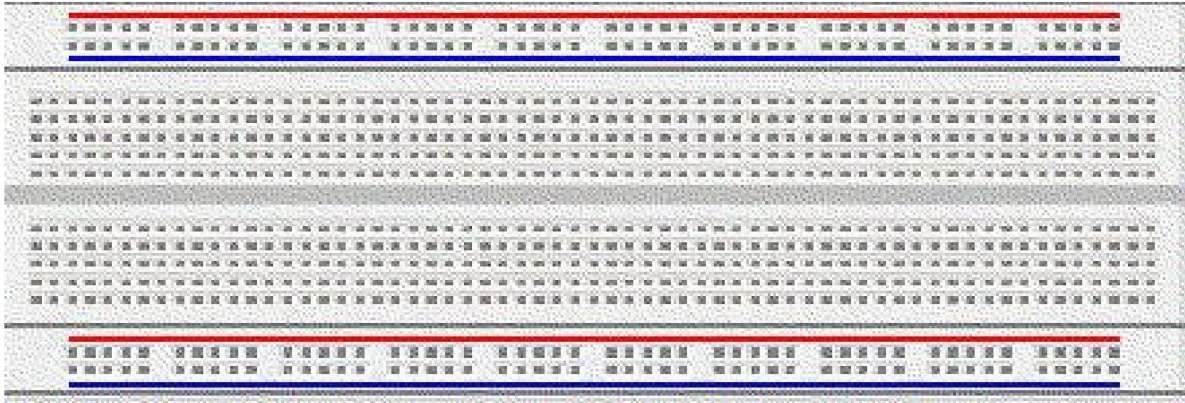
- The bread board has strips of metal which run underneath the board and connect the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally while the remaining holes are connected vertically.

Reference: http://hibp.ecse.rpi.edu/~connor/education/breadboard.pdf
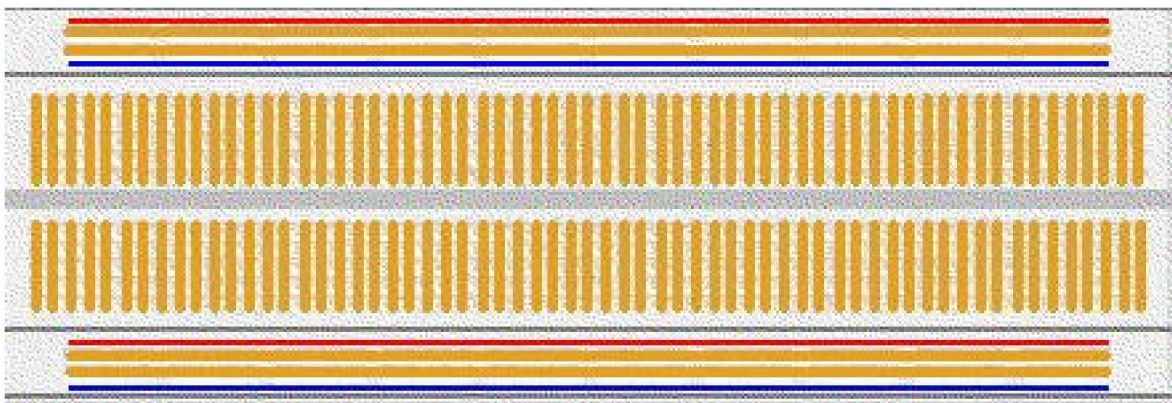
- Breadboard simulation tool

https://123d.circuits.io/circuits/1255805-the-unnamed-circuit#breadboard

3. How to use LEDs?

- LED polarity
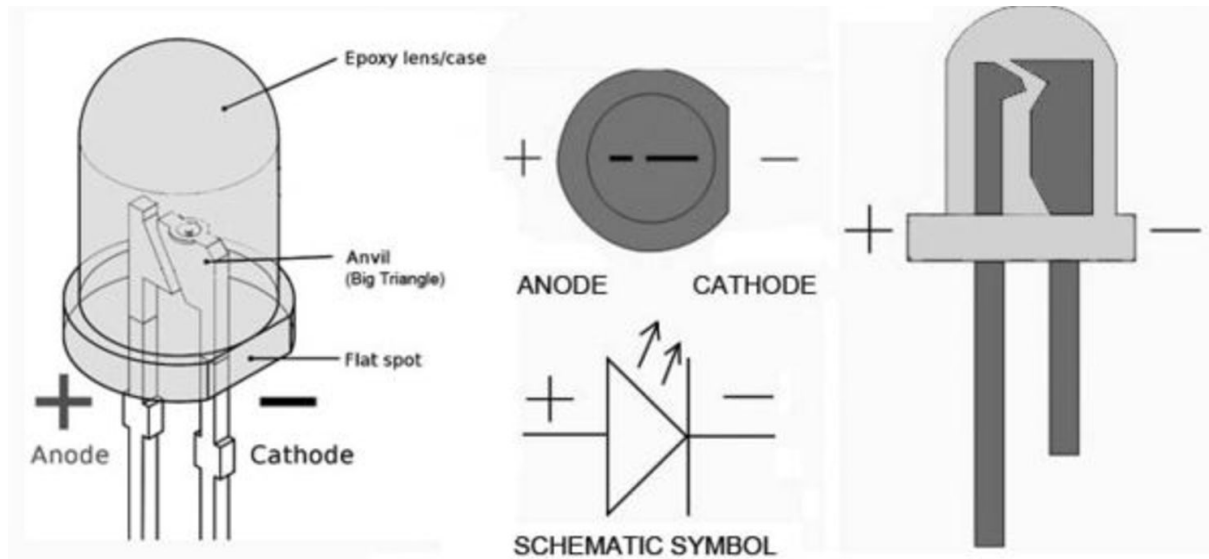
4. Make a prototype for the below circuit.
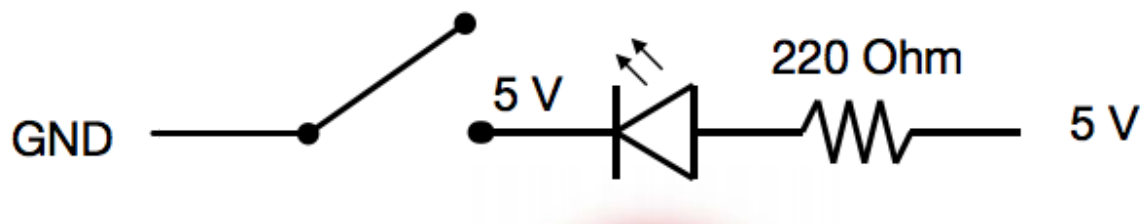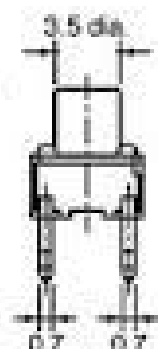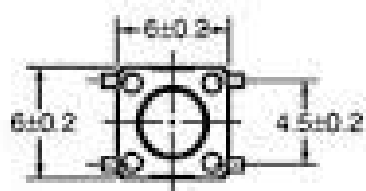
PCB Mounting (Top View)
(Single-sided PCB, t=1.5)

6±0.3
6±0.2
4.5±0.2

0.5 max.
7±0.2
3.4
3.5
(1.6)
0.3
6.5±0.5
7.7±0.5

3.5 dia.

0.7   0.7

4.5±0.1
6.5±0.1
Four,
1±0.05 dia.
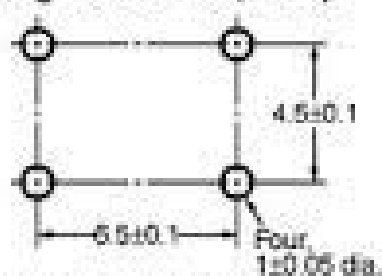
Terminal Arrangement
/Internal Connections
(Top View)

4   3

2   1
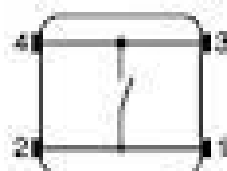
E12 Range, Resistor 220Ω, 5% Tolerance, Carbon Film
www.iamtechnical.com

| Red | Red | Brown | Gold |

5. Make a prototype for the below circuit.

GPIO — (buffer/amplifier) — **5 V** — (LED) — **220 Ohm** — **5 V**

< Active low circuit: LED will be on with the GPIO output 0, off with GPIO output 1>

6. Use a set of Linux shell commands to turn on and off the LED through GPIO control.

- Using "gpio" command
- **IMPORTANT: your GPIO extension board (T-shape PCB) uses BCM numbering. However, the gpio command uses the wPi numbering by default. In order to use the BCM numbering, you should add -g option, for example:**
  - **gpio -g mode 12 out   ==   gpio mode 26 out**

```
[pi@raspberrypi:~ $ gpio readall
 +-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode |   Name  | wPi | BCM |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 |     |     |    3.3v |      |   |  1 || 2  |   |      | 5v      |     |     |
 |   2 |   8 |   SDA.1 |   IN | 1 |  3 || 4  |   |      | 5v      |     |     |
 |   3 |   9 |   SCL.1 |   IN | 1 |  5 || 6  |   |      | 0v      |     |     |
 |   4 |   7 | GPIO. 7 |   IN | 1 |  7 || 8  | 0 |   IN | TxD     | 15  | 14  |
 |     |     |      0v |      |   |  9 || 10 | 1 |   IN | RxD     | 16  | 15  |
 |  17 |   0 | GPIO. 0 |   IN | 0 | 11 || 12 | 0 |   IN | GPIO. 1 | 1   | 18  |
 |  27 |   2 | GPIO. 2 |   IN | 0 | 13 || 14 |   |      | 0v      |     |     |
 |  22 |   3 | GPIO. 3 |   IN | 0 | 15 || 16 | 0 |   IN | GPIO. 4 | 4   | 23  |
 |     |     |    3.3v |      |   | 17 || 18 | 0 |   IN | GPIO. 5 | 5   | 24  |
 |  10 |  12 |    MOSI |   IN | 0 | 19 || 20 |   |      | 0v      |     |     |
 |   9 |  13 |    MISO |   IN | 0 | 21 || 22 | 0 |   IN | GPIO. 6 | 6   | 25  |
 |  11 |  14 |    SCLK |   IN | 0 | 23 || 24 | 1 |   IN | CE0     | 10  | 8   |
 |     |     |      0v |      |   | 25 || 26 | 1 |   IN | CE1     | 11  | 7   |
 |   0 |  30 |   SDA.0 |   IN | 1 | 27 || 28 | 1 |   IN | SCL.0   | 31  | 1   |
 |   5 |  21 | GPIO.21 |   IN | 1 | 29 || 30 |   |      | 0v      |     |     |
 |   6 |  22 | GPIO.22 |   IN | 1 | 31 || 32 | 0 |   IN | GPIO.26 | 26  | 12  |
 |  13 |  23 | GPIO.23 |   IN | 0 | 33 || 34 |   |      | 0v      |     |     |
 |  19 |  24 | GPIO.24 |   IN | 0 | 35 || 36 | 0 |   IN | GPIO.27 | 27  | 16  |
 |  26 |  25 | GPIO.25 |   IN | 0 | 37 || 38 | 0 |   IN | GPIO.28 | 28  | 20  |
 |     |     |      0v |      |   | 39 || 40 | 0 |   IN | GPIO.29 | 29  | 21  |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode |   Name  | wPi | BCM |
 +-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+
```
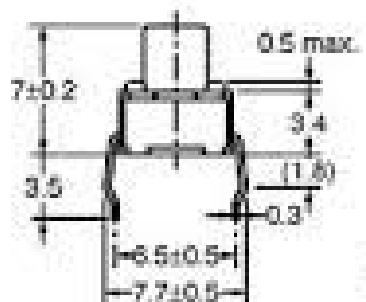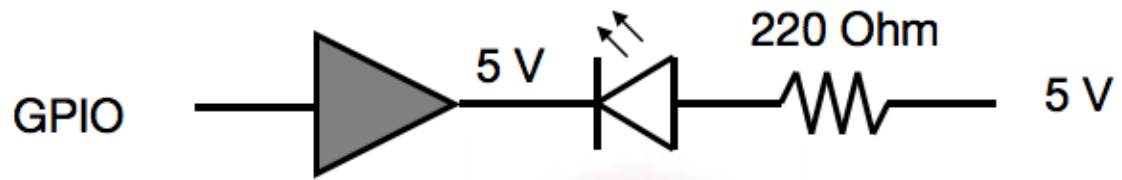
```
[pi@raspberrypi:~ $ gpio mode 22 out
[pi@raspberrypi:~ $ gpio readall
+-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+
| BCM | wPi |   Name  | Mode | V | Physical | V | Mode |   Name  | wPi | BCM |
+-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
|     |     |    3.3v |      |   |  1 || 2  |   |      | 5v      |     |     |
|   2 |   8 |   SDA.1 |   IN | 1 |  3 || 4  |   |      | 5v      |     |     |
|   3 |   9 |   SCL.1 |   IN | 1 |  5 || 6  |   |      | 0v      |     |     |
|   4 |   7 |  GPIO. 7|   IN | 1 |  7 || 8  | 0 |   IN | TxD     | 15  | 14  |
|     |     |      0v |      |   |  9 || 10 | 1 |   IN | RxD     | 16  | 15  |
|  17 |   0 |  GPIO. 0|   IN | 0 | 11 || 12 | 0 |   IN | GPIO. 1 | 1   | 18  |
|  27 |   2 |  GPIO. 2|   IN | 0 | 13 || 14 |   |      | 0v      |     |     |
|  22 |   3 |  GPIO. 3|   IN | 0 | 15 || 16 | 0 |   IN | GPIO. 4 | 4   | 23  |
|     |     |    3.3v |      |   | 17 || 18 | 0 |   IN | GPIO. 5 | 5   | 24  |
|  10 |  12 |    MOSI |   IN | 0 | 19 || 20 |   |      | 0v      |     |     |
|   9 |  13 |    MISO |   IN | 0 | 21 || 22 | 0 |   IN | GPIO. 6 | 6   | 25  |
|  11 |  14 |    SCLK |   IN | 0 | 23 || 24 | 1 |   IN | CE0     | 10  | 8   |
|     |     |      0v |      |   | 25 || 26 | 1 |   IN | CE1     | 11  | 7   |
|   0 |  30 |   SDA.0 |   IN | 1 | 27 || 28 | 1 |   IN | SCL.0   | 31  | 1   |
|   5 |  21 | GPIO.21 |   IN | 1 | 29 || 30 |   |      | 0v      |     |     |
|   6 |  22 | GPIO.22 |  OUT | 0 | 31 || 32 | 0 |   IN | GPIO.26 | 26  | 12  |
|  13 |  23 | GPIO.23 |   IN | 0 | 33 || 34 |   |      | 0v      |     |     |
|  19 |  24 | GPIO.24 |   IN | 0 | 35 || 36 | 0 |   IN | GPIO.27 | 27  | 16  |
|  26 |  25 | GPIO.25 |   IN | 0 | 37 || 38 | 0 |   IN | GPIO.28 | 28  | 20  |
|     |     |      0v |      |   | 39 || 40 | 0 |   IN | GPIO.29 | 29  | 21  |
+-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
| BCM | wPi |   Name  | Mode | V | Physical | V | Mode |   Name  | wPi | BCM |
+-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+

[pi@raspberrypi:~ $ gpio write 22 1
[pi@raspberrypi:~ $ gpio readall
+-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+
| BCM | wPi |   Name  | Mode | V | Physical | V | Mode |   Name  | wPi | BCM |
+-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
|     |     |    3.3v |      |   |  1 || 2  |   |      | 5v      |     |     |
|   2 |   8 |   SDA.1 |   IN | 1 |  3 || 4  |   |      | 5v      |     |     |
|   3 |   9 |   SCL.1 |   IN | 1 |  5 || 6  |   |      | 0v      |     |     |
|   4 |   7 |  GPIO. 7|   IN | 1 |  7 || 8  | 0 |   IN | TxD     | 15  | 14  |
|     |     |      0v |      |   |  9 || 10 | 1 |   IN | RxD     | 16  | 15  |
|  17 |   0 |  GPIO. 0|   IN | 0 | 11 || 12 | 0 |   IN | GPIO. 1 | 1   | 18  |
|  27 |   2 |  GPIO. 2|   IN | 0 | 13 || 14 |   |      | 0v      |     |     |
|  22 |   3 |  GPIO. 3|   IN | 0 | 15 || 16 | 0 |   IN | GPIO. 4 | 4   | 23  |
|     |     |    3.3v |      |   | 17 || 18 | 0 |   IN | GPIO. 5 | 5   | 24  |
|  10 |  12 |    MOSI |   IN | 0 | 19 || 20 |   |      | 0v      |     |     |
|   9 |  13 |    MISO |   IN | 0 | 21 || 22 | 0 |   IN | GPIO. 6 | 6   | 25  |
|  11 |  14 |    SCLK |   IN | 0 | 23 || 24 | 1 |   IN | CE0     | 10  | 8   |
|     |     |      0v |      |   | 25 || 26 | 1 |   IN | CE1     | 11  | 7   |
|   0 |  30 |   SDA.0 |   IN | 1 | 27 || 28 | 1 |   IN | SCL.0   | 31  | 1   |
|   5 |  21 | GPIO.21 |   IN | 1 | 29 || 30 |   |      | 0v      |     |     |
|   6 |  22 | GPIO.22 |  OUT | 1 | 31 || 32 | 0 |   IN | GPIO.26 | 26  | 12  |
|  13 |  23 | GPIO.23 |   IN | 0 | 33 || 34 |   |      | 0v      |     |     |
|  19 |  24 | GPIO.24 |   IN | 0 | 35 || 36 | 0 |   IN | GPIO.27 | 27  | 16  |
|  26 |  25 | GPIO.25 |   IN | 0 | 37 || 38 | 0 |   IN | GPIO.28 | 28  | 20  |
|     |     |      0v |      |   | 39 || 40 | 0 |   IN | GPIO.29 | 29  | 21  |
+-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
| BCM | wPi |   Name  | Mode | V | Physical | V | Mode |   Name  | wPi | BCM |
+-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+
```

```
[pi@raspberrypi:~ $ gpio write 22 0
[pi@raspberrypi:~ $ gpio readall
 +-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode | Name    | wPi | BCM |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 |     |     |    3.3v |      |   |  1 || 2  |   |      | 5v      |     |     |
 |   2 |   8 |   SDA.1 |   IN | 1 |  3 || 4  |   |      | 5v      |     |     |
 |   3 |   9 |   SCL.1 |   IN | 1 |  5 || 6  |   |      | 0v      |     |     |
 |   4 |   7 | GPIO. 7 |   IN | 1 |  7 || 8  | 0 |   IN | TxD     | 15  | 14  |
 |     |     |      0v |      |   |  9 || 10 | 1 |   IN | RxD     | 16  | 15  |
 |  17 |   0 | GPIO. 0 |   IN | 0 | 11 || 12 | 0 |   IN | GPIO. 1 | 1   | 18  |
 |  27 |   2 | GPIO. 2 |   IN | 0 | 13 || 14 |   |      | 0v      |     |     |
 |  22 |   3 | GPIO. 3 |   IN | 0 | 15 || 16 | 0 |   IN | GPIO. 4 | 4   | 23  |
 |     |     |    3.3v |      |   | 17 || 18 | 0 |   IN | GPIO. 5 | 5   | 24  |
 |  10 |  12 |    MOSI |   IN | 0 | 19 || 20 |   |      | 0v      |     |     |
 |   9 |  13 |    MISO |   IN | 0 | 21 || 22 | 0 |   IN | GPIO. 6 | 6   | 25  |
 |  11 |  14 |    SCLK |   IN | 0 | 23 || 24 | 1 |   IN | CE0     | 10  | 8   |
 |     |     |      0v |      |   | 25 || 26 | 1 |   IN | CE1     | 11  | 7   |
 |   0 |  30 |   SDA.0 |   IN | 1 | 27 || 28 | 1 |   IN | SCL.0   | 31  | 1   |
 |   5 |  21 | GPIO.21 |   IN | 1 | 29 || 30 |   |      | 0v      |     |     |
 |   6 |  22 | GPIO.22 |  OUT | 0 | 31 || 32 | 0 |   IN | GPIO.26 | 26  | 12  |
 |  13 |  23 | GPIO.23 |   IN | 0 | 33 || 34 |   |      | 0v      |     |     |
 |  19 |  24 | GPIO.24 |   IN | 0 | 35 || 36 | 0 |   IN | GPIO.27 | 27  | 16  |
 |  26 |  25 | GPIO.25 |   IN | 0 | 37 || 38 | 0 |   IN | GPIO.28 | 28  | 20  |
 |     |     |      0v |      |   | 39 || 40 | 0 |   IN | GPIO.29 | 29  | 21  |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode | Name    | wPi | BCM |
 +-----+-----+---------+------+---+---Pi 3---+---+------+---------+-----+-----+
pi@raspberrypi:~ $ ▮
```

- Alternative way

$ sudo su

Connect an LED using a resistor between GPIO22 and GND.

Creating a File access to GPIO using console commands:

If you write to the *./export* file in the */sys/class/gpio/* subdirectory, the system creates a file with a GPIO structure according to the input. In this case we want to create an access to write directly to GPIO22 in order to handle an LED.

Create a GPIO file access:
$ echo 22 > /sys/class/gpio/export

Configure the Pin Direction (In/Out):
$ echo out > /sys/class/gpio/gpio22/direction

Write a value to turn on the LED using the GPIO22:
$ echo 1 > /sys/class/gpio/gpio22/value

Now your led should be ON!!!

Write a value to clear the LED using the GPIO22

```
$ echo 0 > /sys/class/gpio/gpio22/value
```

Now your led should be OFF!!!

Delete the created GPIO (22)
```
$ echo 22 > /sys/class/gpio/unexport
```

Reference: https://sites.google.com/site/semilleroadt/raspberry-pi-tutorials/gpio