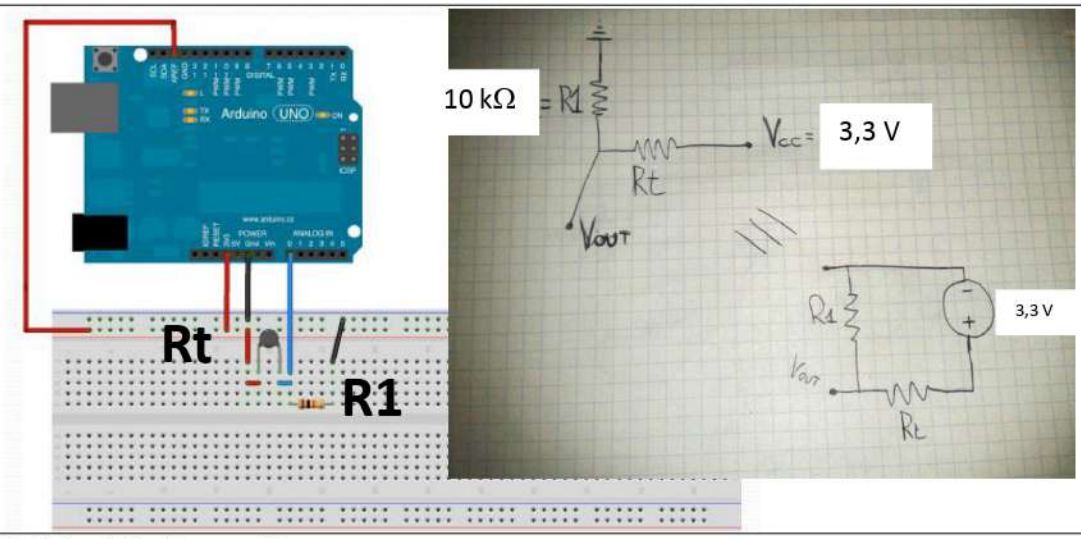
	School of Science and Technology **Computer Science** **Embedded Systems Architecture** *Prof. Lorenzo Morresi*	MSc in Computer Science (LM-18) A.A. 2019-2020
Project Title	**Temperature monitor system**	Sheet ARDUINO n_**2**
Description	Make an Arduino sketch that allows the acquisition of the room temperature values (expressed in °C) every two seconds and write the value on the 9600 serial monitor. The sketch must also write the values of the resistance of the sensor that acquires the temperature.	
Necessary materials	ARDUINO UNO board 1 resistor - 10 kΩ 1 thermistor - 4,7 kΩ 1 resistor - 5 kΩ	

Sketch

```
int pin = A0;
double VOLT = 3.3;
double v;                       /*voltaggio tra 0 e 1023*/
double volt;                    /* voltaggio reale tra o e 3,3 volt*/
double Rt;                      /* resistenza del termistore*/
double R1 = 10000;              /*resistenza in ohm che abbiamo messo noi*/
double temp;                    /* temperatura in Kelvin*/
double Temperatura;             /* temperatura in Celsius*/

void setup(){

 Serial.begin(9600);              /*usiamo il display seriale*/
 analogReference(EXTERNAL);    /*questa linea NON può essere tolta. Se la Reference viene
tolta il sistema perde la calibrazione*/
}

void loop(){

 v=analogRead(pin);       /*leggiamo il valore della tensione ai capi di R1*/

 volt=VOLT*v/1023;       /* riportiamo la tensiOne tra 0 e 3,3 volt con una proporzione*/

 Rt=R1*(VOLT/volt)-R1;          /*resistenza del termistore*/

 temp=1/(0.001319+(0.000234125*log(Rt))+(0.0000000876741*log(Rt)*log(Rt)*log(Rt)));
/*calcolo la temperatura con la formula di Steinhart-Hart*/

 Temperatura=temp-273.15;     /* gradi Celsius*/

 Serial.println("temperatura");  /*stampiamo sul monitor la temperatura*/
 Serial.println(Temperatura);    /*stampo il valore della teperatura*/
 Serial.println("resistenza");     /*stampiamo sul monitor la termoresistenza*/
 Serial.println(Rt);              /*stampo il valore della resistenza*/
 delay(2000);                     /*ritardo di due secondi*/
}
```

Pictorial /Schematic	
	Steinhart-Hart's equation Accurate measurement of the resistance / temperature relationship of NTC thermistors we use the Steinhart-Hart's equation which allows an approximation of the third order: $$\frac{1}{T} = A_0 + A_1 ln(R) + A_3 ln(R)^3 \cdot$$ where A_0, A_1 e A_3 are the Steinhart-Hart parameters with specific values for different devices. T is the temperature in kelvin and R is the resistance in ohm. In our case is: $A_0 = 0.001319$ $A_1 = 0.000234125$ $A_3 = 0.0000000876741$ Precise values can be obtained by following the calibration procedure shown on the following link: http://www.thinksrs.com/downloads/programs/Therm%20Calc/NTCCalibrator/NTCcalculator.htm
Sizing	The circuiti is a voltage divider formed by the resistor R1=10 kΩ and the thermistor Rt. Vout, as you can see on the schematic circuit, is given by: Vout=Vcc*R1/(R1+Rt) where Vcc = 3,3 V If you need to use other values of both R1 and Vcc, it would be enough to update the sketch with new values.
Try to	Replace the resistor R1 = 10 kΩ with a 5 kΩ ones and then check the correct temperature measurement of the thermistor
Try to	Change Vcc = 3,3 V by using the 5 V output on the ARDUINO board and then check the correct temperature measurement of the thermistor
Try to	Add a LED (refer to sheet ARDUINO_#1) and change the sketch in order to get a system that turn on the LED when temperature exceeds a fixed set point.