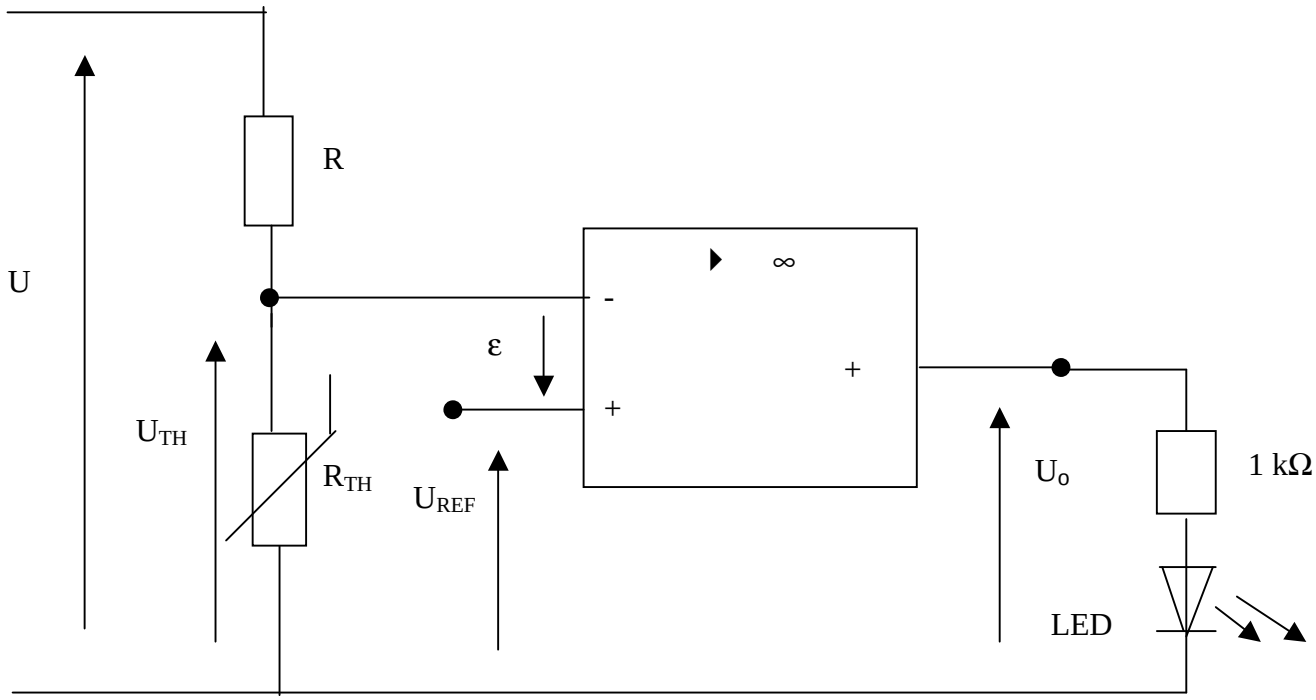
ORAL WORK ON VOLTAGE COMPARATOR CIRCUIT

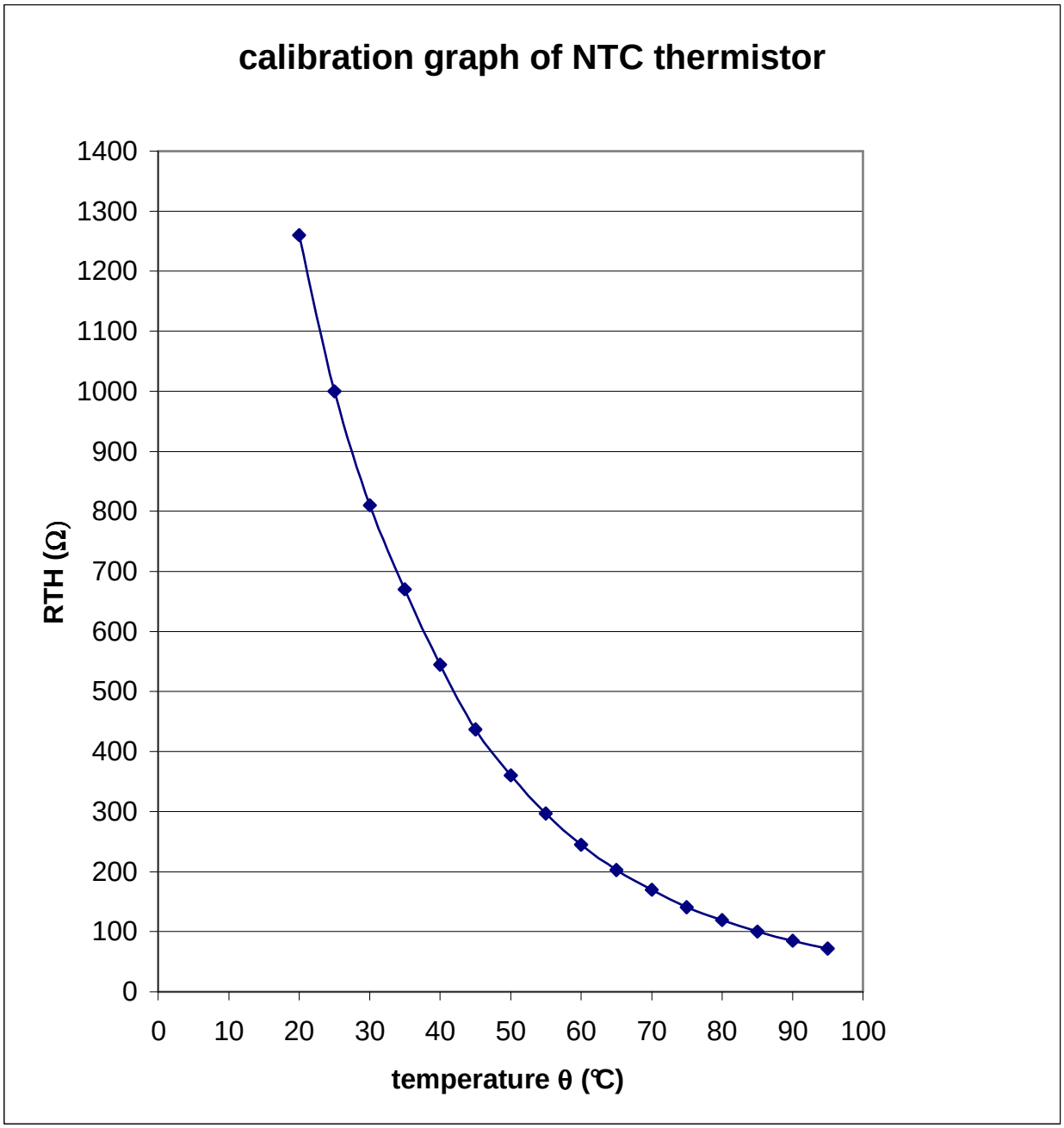
PART 1

The following circuit is given:



U = constant voltage = 10 V ; U_{REF} = reference voltage = 3 V;
R_{TH} = resistance of a NTC type thermistor depending on temperature θ.
(The graph of R_{TH} against temperature θ is given on page N°2)
The operational amplifier is supposed to be ideal and functions **non-linearly**:
Output voltage U_o can take 2 values $+V_{SAT}$ = 15 V and $– V_{SAT}$ = - 15 V.

a) Give ε in terms of U_{REF} and U_{TH}.
b) Apply the voltage divider formula to give U_{TH} in terms of U, R and R_{TH}.
c) What is the value of R_{TH} when temperature θ = 25 °C ? Calculate U_{TH} at this temperature.
d) What is the value of R_{TH} when temperature θ = 55 °C ? Calculate U_{TH} at this temperature.
e) U_{TH} = 5 V at temperature θ = 25 °C. Give the value of U_o and say whether the LED lights or not.
f) U_{TH} = 2.3 V at temperature θ = 55 °C. Give the value of U_o and say whether the LED lights or not.
g) Give an application for the circuit.

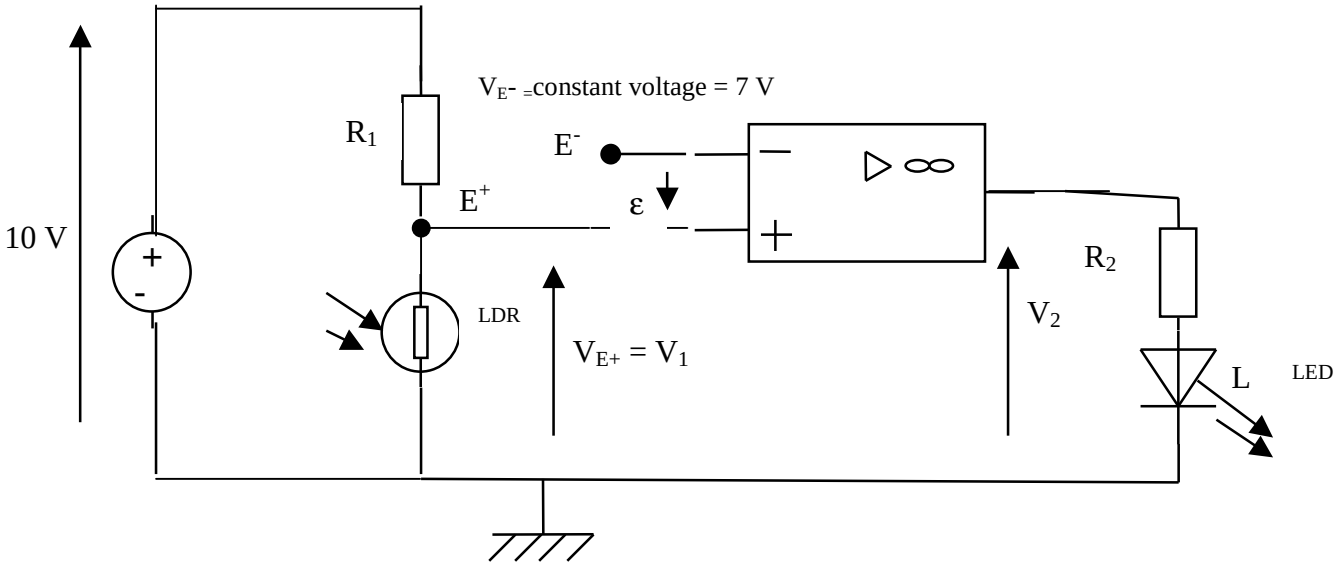

calibration graph of NTC thermistor
RTH (Ω)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
90
100
temperature θ (℃)

PART 2

ABOUT SENSORS

Sensors convert physical quantities into electric quantities. Sensors can depend on heat, light and strain.
An example of heat sensor is the thermistor whose resistance changes when temperature changes.
An example of light sensor is the light-dependent resistor (LDR) whose resistance changes when the intensity of light falling on it changes.
An example of strain sensor is the strain gauge which converts mechanical strain into a resistance change.

We are going to consider a light-dependent resistor associated to a voltage comparator circuit



In presence of light the resistance of the LDR is equal to 1 kΩ and in absence of light the resistance of the LDR is equal to 10 MΩ.
The LED and op amp are supposed to be ideal. The op amp uses a symmetrical DC power supply = $\pm V_{CC} = \pm 15$ V and $R_1 = R_2 = 1$ kΩ.

PART 1 (study of the LDR circuit)

a) The op amp being ideal, how are the LDR and R_1 connected ?
b) Apply the voltage divider formula to calculate V_1 in the presence of light.
c) Apply the voltage divider formula to calculate V_1 in the absence of light.

PART 2 (study of the voltage comparator circuit)

d) Give the names of the 2 inputs E^+ and E^- of the op amp.
e) Does the op amp function linearly or non – linearly ? Explain why.
f) Give the 2 possible values of V_2.

g) Give ε in terms V_{E+} and V_{E-}.

We assume that V_1 = 5 V or 10 V.

h) Give the utility of resistance R_2.
i) When V_1 = 5 V the LED does not light. Explain why.
j) When V_1 = 10 V the LED lights. Explain why.
k) Give an application for the circuit.