RESEARCH & PROJECT SUBMISSIONS

Program:

Course Code: CSE 271

Course Name: ***System Dynamics & Control Components***

Examination Committee

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Ain Shams University
Faculty of Engineering
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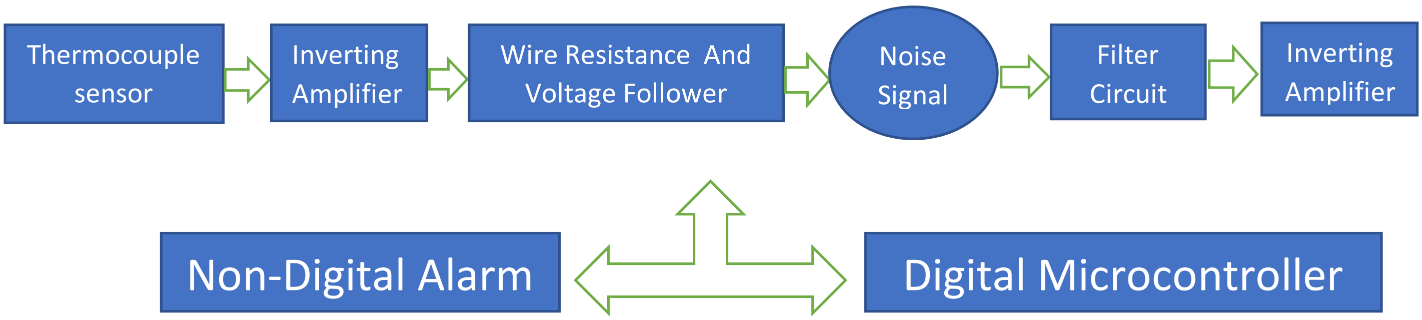
Submission Contents

First Topic

System Diagram With Description



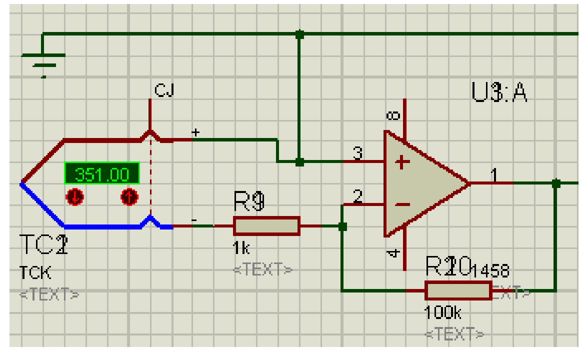
General Description:

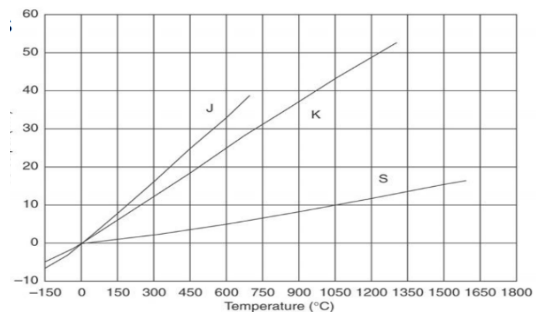
We have used a thermocouple sensor because of its wide range (-190:1260) and then connecting this sensor to amplifier to amplify the voltage difference of sensor from millivolt to volt, then pass the amplified signal on resistance which represent a copper wire with length 100m and then pass the signal on a voltage follower amplifier to avoid the load effect without affecting on the gain. And now we will add a noise signal (6 kHz) so we will use summing amplifier to add this noise signal to our main signal and then pass the output signal from the amplifier to a filter (LPF) and make its cut off frequency very low to make output signal from filter almost DC signal but with low voltage range, so now the final stage of design to pass this signal on another inverting amplifier to make the output voltage's range wider. Now our circuit is to pass it on a digital microcontroller or a non-digital alarm. For the digital microcontroller we have used arduino uno and virtual terminal to show the input and a buzzer to give an alarm when we exceed the maximum temperature. And for non-digital alarm we have use a hysteresis comparator and a led to give light when we exceed the maximum temperature as an alarm.

Second Topic

System Modules Description And Assumptions

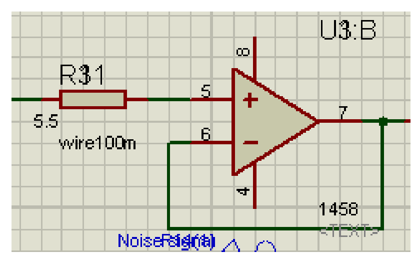
1) Thermocouple and Inverting Amplifier:





So we have used thermocouple temperature sensor because of its wide range and we have used K-type thermocouple which is a Chromel-alumel material and its temperature range (-190:1260) degree Celsius, and another reason for using thermocouple is that this type of sensor is almost linear with voltage as the second picture represent but with the change in temperature it give a narrow change in voltage which is measured in millivolts. So this take us to second stage on an inverting amplifier and to amplify the gain we have assumed the amplifier resistances are (R1=1k,R2=100k) as shown in first picture so after this amplifier stage the signal from sensor have been amplified from millivolt to volt and have been inverted also so for this reason we selected negative sensor terminal to be the signal input to amplifier and connect its positive terminal to ground. (Av=-R2/R1=-100k/1k=100)

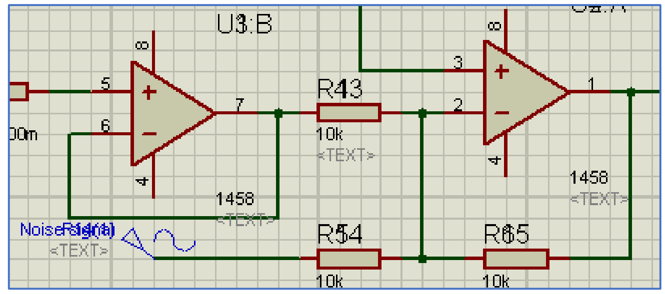
2) Wire Resistance and Voltage Follower:



In this stage we have to represent a wire of 100m length in our project design as this wire carry the signal to the control room, so we have represented the wire in form of resistance so we have assumed the following (Area= $5mm^2$, $\alpha(copper @ 20^0 c) = 0.0393$,length=100m), and then according to the next relation we get the value of resistance (@ $20^0 c$) so relation will be $R_{reff} = \alpha \frac{L}{A} = 0.336\Omega$ so this is the resistance at $20^0 c$ and we want wire to bear up to $400^0 c$ so we use the following relation for correction with assumptions (T= $400^0 c$, $\alpha = 0.0393, R_{reff} = 0.336\Omega, T_{reff} = 20^0 c$) so sub in the relation: $R = R_{reff}(1+\alpha(T - T_{reff})) = 5.5\Omega$.

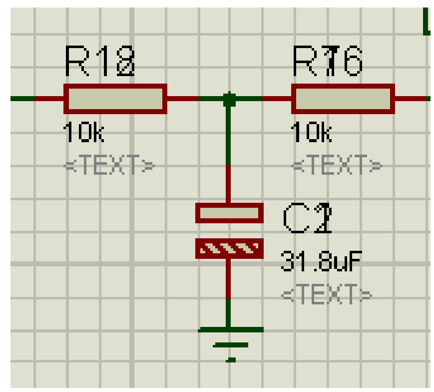
And then we use voltage follower to avoid the load effect without affecting on the gain and it also known as buffer circuit.

3) Inserting a Noise Signal:



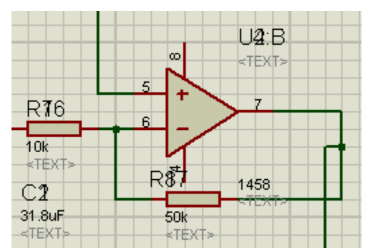
We have used a sine wave generator to produce a noise signal and assume (wave Amplitude=5 volt, wave frequency= 6kHZ) we couldn't adjust the frequency of noise as required (60kHz) due to the CPU load and also because the second of proteus program not equal the real life second which have affect the results, and then use summing op-amp to add this noise signal to our main input signal as shown in the picture and according to the following relation get the output of amplifier $V_{out} = -[\frac{R2}{R1}V_1 + \frac{R2}{R3}V_2]$.

4) Filtering the Signal:



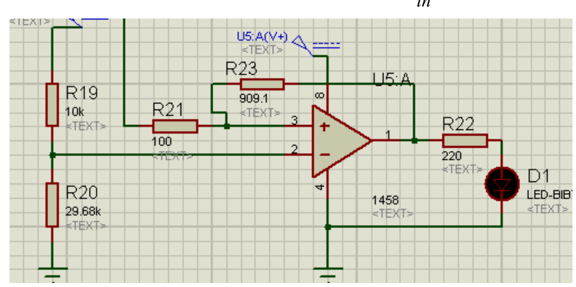
In this stage we want to remove so we used low pass filter to perform this stage and we have adjust the cut off frequency of filter to be very low ($f_c = 0.5Hz$) we did that to make the output of filter nearly act as DC signal and we have assumed (R=10k) so from this relation ($f_c = \frac{1}{2\pi RC}$) we get the value of capacitor ($C = 31.8\mu F$).

5) Final Amplifier Stage:



The signal have been affected by wire resistance and noise signal and also the filtering stage so it have been minimized to millivolt range another time so we adjust an inverting amplifier to make the final signal delivered to controller in volt range and also amplification happens according to following relation $\frac{V_{out}}{V_{in}} = -\frac{R2}{R1}$.

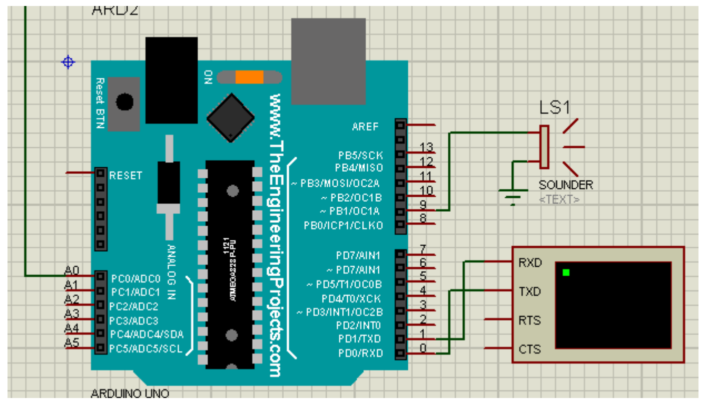
6) Non-Digital Alarm Circuit:



We have designed non-digital alarm using a hysteresis comparator as shown in the following picture and we have to adjust low voltage @T=340 and high voltage @T=350, so $V_l = 3.82volt, V_h = V_{reff} = 3.92volt$, but we face a problem that led didn't operate @ $V_{reff} = 3.92$, so by comparing we find that to adjust comparator @T=350, we have to adjust $V_{reff} = 3.74volt$ and at this case the comparator have worked well as an alarm and according to the following relation ($V_l = V_{reff} - \frac{R}{R_f} V_o$) we have assumed the value of (R=100) and then the value of ($R_f = 909.1$).

And also we have used a voltage divider circuit to give us $V_{reff} = 3.74volt$ and adjust the values of resistances to perform that according to the following relation ($V_o = V_s \frac{R2}{R2+R1}$) and assume that value of (R1=10k) and (Vs=5volt) so (R2=29.68K). and then we use the led as indicator when the temperature exceed 350.

7) Digital Microcontroller:



In this stage we have used an arduino uno as a digital microcontroller and we write the code (will be shown later) and upload it to the arduino and connect it to a virtual terminal which is used to show the output of temperature and the average temperature and use sounder (LS1) to act as alarm when the temperature exceed the maximum temperature (T=350) and connect it to pin 9.

Third Topic

Microcontroller Program Code

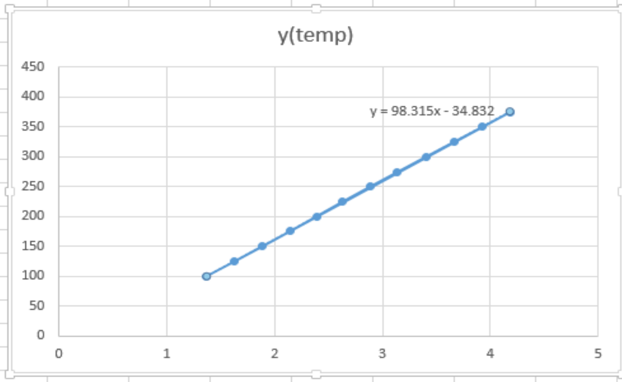
```
int tempPin=0;
float sum=0;
float val[60];
float avg;
float cel;
int i;
void setup(){
  Serial.begin(9600);
  pinMode(9,OUTPUT);
```

```
  delay(850);
}
void loop(){
  for(i=1;i<=60;i++){
  val[i]=analogRead(tempPin);
  cel = val[i]*0.0048828125;
  float t=(98.315*cel)-34.832;
  sum+=t;
  Serial.print(i);
  Serial.print("       ");
  Serial.println(t);
  if(t>351.5){
    digitalWrite(9,HIGH);
  }
  if(t<351.5){
    digitalWrite(9,LOW);
  }
  if(i==60){
  avg=sum/60;
  Serial.print("Temperature = ");
  Serial.print(t);
  Serial.print("*c");
  Serial.print("         Avg Temperature = ");
  Serial.print(avg);
  Serial.println();
  sum=0;
  i=0;
  }
  delay(38);
  }
}
```

Code Description and Notes:

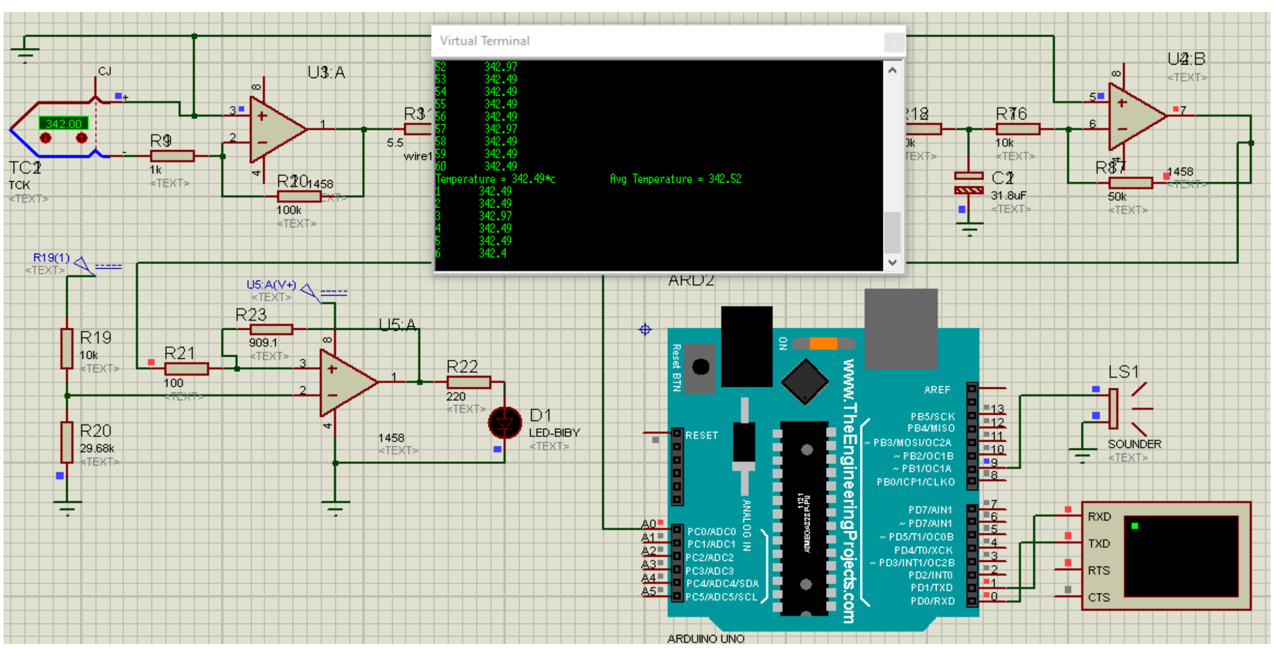
- We have put a delay in void setup to make the code wait until the input voltage to the microcontroller reach the steady state and waiting time on system will equal 850 milliseconds while the real-life waiting time will be nearly 26 seconds.
- We have used an array function to store the input data every second and take the average every minute and show the input at this moment.
- We used a correction factor of arduino to read input clearly and this correction factor equal (5/1024).
- Then we also used another correction factor for temperature readings to make it as possible as linear equation and use the formula showed in the following picture.

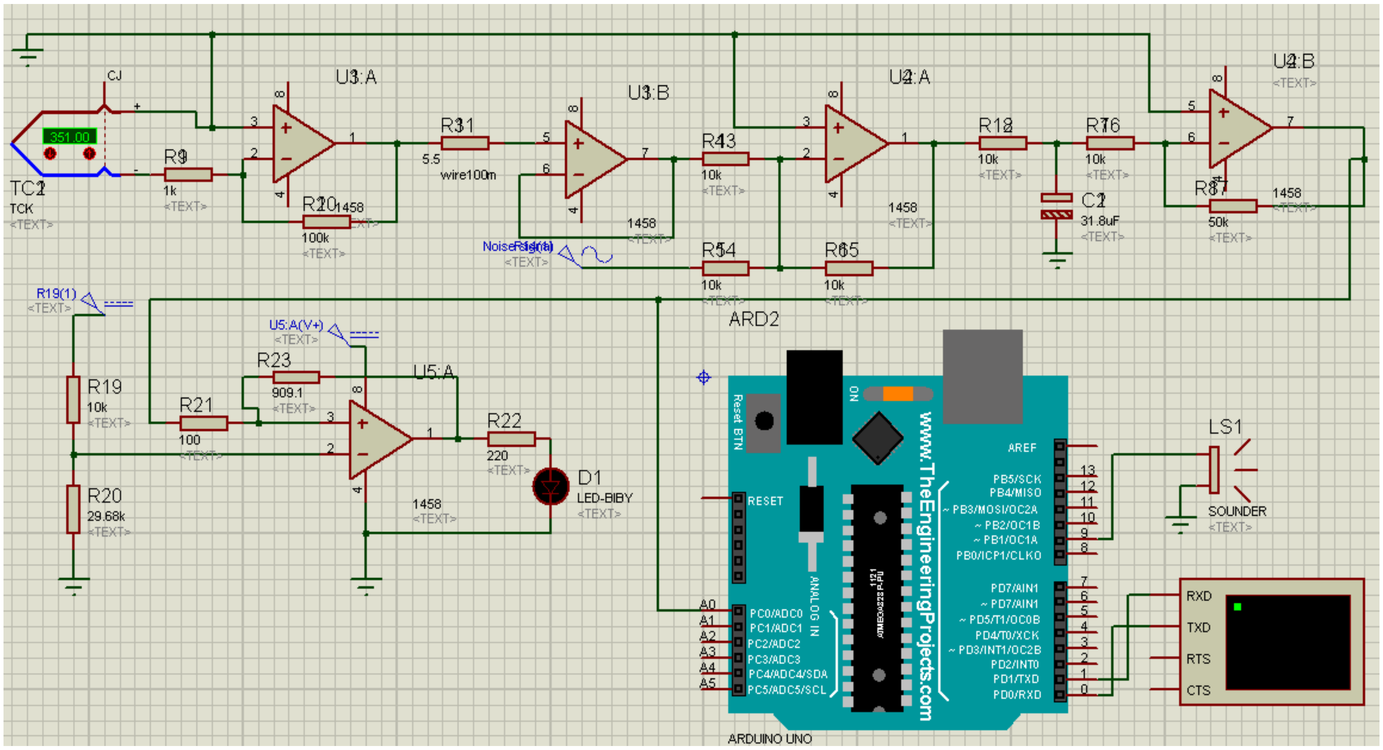
x(volt)	y(temp)
1.37	100
1.89	150
2.39	200
2.89	250
3.4	300
3.92	350
4.18	375
1.63	125
2.14	175
2.63	225
3.14	275
3.66	325



Fourth Topic

Complete Circuit Diagram





Fifth Topic

Component List

Component	IC Name	Use
K-Type Thermocouple	TCK	Used as sensor
Capacitors	CAP / CAP-ELEC	Used in filter
Microcontroller	ARDUINO UNO	Used as digital microcontroller
Led	LED-BIBY	Used as indicator/alarm
Resistances	RES	Used in design amplifiers and whole circuit
OP-AMP	1458	Used in design amplifiers and whole circuit
Buzzer	SOUNDER LS1	Used as an alarm in digital microcontroller
Display	VIRTUAL TERMINAL	Used to display data from ARDUINO
DC Generator	DC	Provide circuit with DC signal

AC Generator	SINE	Provide circuit with AC signal

Sixth Topic

Team, Role Of Each Member In This Project

Team Name: Jesse Lingard Lovers

Name	Code	Member's Role
Ahmed Ayman Ahmed Hassan	1700037	Design the non-digital alarm circuit and editing the delivery files
Ahmed Atef Mohamed Saied	1700106	Make the design of sensor circuit with wire resistance and noise signal
Khaled Tarek Abdelfatah Ibrahim	1700477	Make the design of sensor circuit with wire resistance and noise signal
Abdelrahman Mo'men Atef Abas	1700752	Deal with the digital microcontroller and write the code