Design a Luxmeter with an LDR and an Arduino

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İntroduciton:

In today's rapidly advancing world of lighting technologies, accurately measuring the quality and quantity of light has become increasingly important. Lux meters emerge as a crucial tool in this context. A lux meter is a device that measures the intensity of light in various lighting conditions, providing a numerical expression of the light level in the environment.Lux meters calculate the amount of light per lumen, expressing the lighting level in a numerical format. This measurement is utilized in the evaluation of lighting designs, energy-saving planning, agricultural applications, photography, construction sites, and various other fields.These unique devices typically utilize photoelectric cells or sensors to detect light intensity. Compact in design and user-friendly, lux meters find widespread use in various industrial settings, offices, homes, and laboratories.Lux meters play a pivotal role in determining the lighting level of an environment, contributing to comfort, safety, and efficiency. Calibrated to meet various light-related standards and ensure accurate measurements, these devices are indispensable tools in the successful planning and implementation of modern lighting solutions.Measuring the power of light assists professionals in making informed decisions across diverse sectors. With their high precision and reliable performance, lux meters offer a vital measurement tool, providing a quality measurement experience in the world of lighting.

Figure 1Digital Light Meter

Light-dependent resistors, also called photoresistors or photoconductors, play an important role in light-dark sensing circuits, providing versatility in a variety of applications.Typically, the resistance of an LDR is high in the absence of light, but decreases significantly when exposed to light.These components are the basis for circuits designed to automatically respond to ambient light levels, such as solar-powered garden lights or nighttime security lights.As shown in Figure 2, under low ambient light conditions, LDRs exhibit high resistance.In this state, the resistance increases so that no current flows from point A to point B, and this property allows the LDR to act as a sensitive switch and automatically control electronic circuits based on typical lighting conditions.

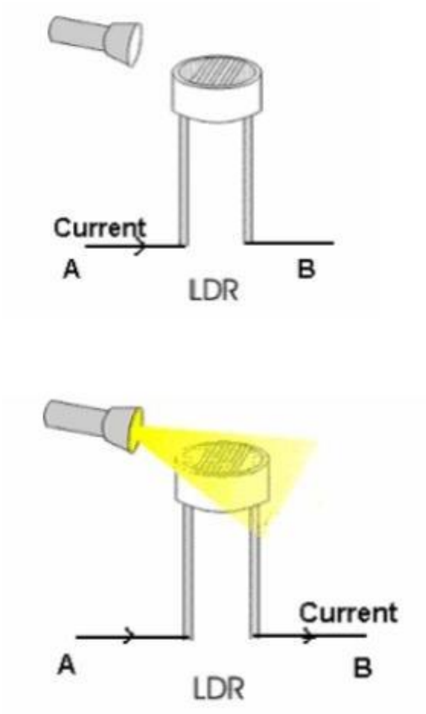


Figure 2 Working princible of LDR

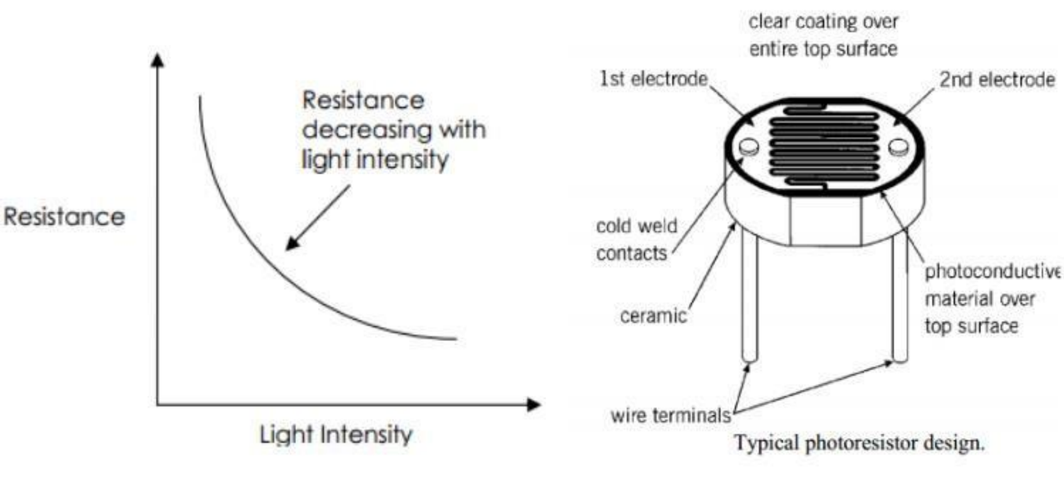


Figure 3

Electrical Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Cell resistance	1000 LUX 10 LUX	- -	400 9	- -	Ohm K Ohm
Dark Resistance	-	-	1	-	M Ohm
Dark Capacitance	-	-	3.5	-	pF
Rise Time	1000 LUX 10 LUX	- -	2.8 18	- -	ms ms
Fall Time	1000 LUX 10 LUX	- -	48 120	- -	ms ms
Voltage AC/DC Peak		-	-	320	V max
Current		-	-	75	mA max
Power Dissipation				100	mW max
Operating Temperature		-60	-	+75	Deg. C

Figurel 4 Electrical Characteristics Features of LDR

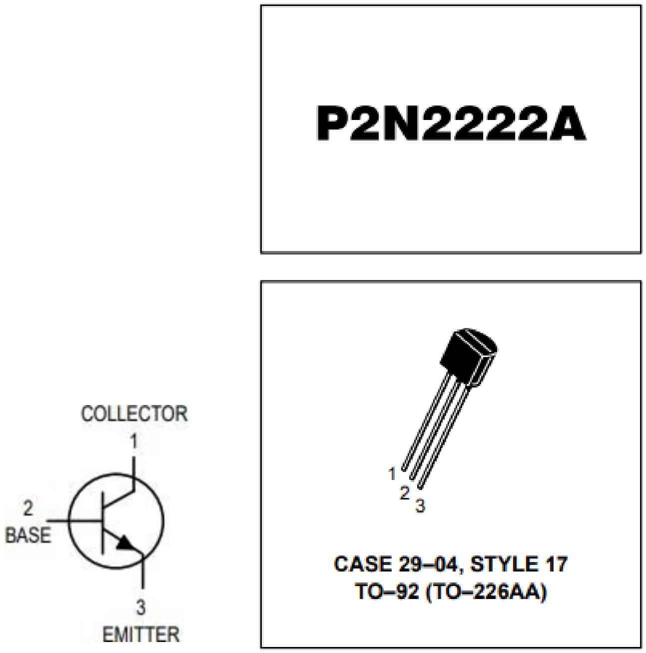
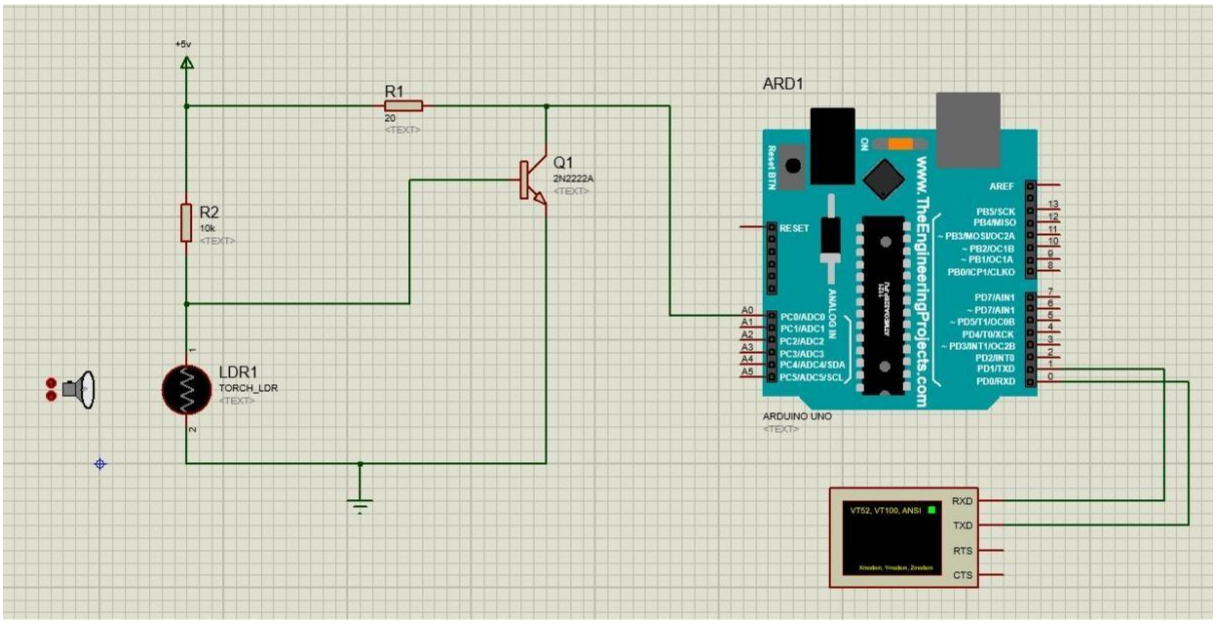


Figure 5 P2N2222A(BJT) information

When the base voltage is raised to a sufficient level, current initiates its flow from the collector (3) to the emitter (1). In the active state, current traverses through the LED and transistor, with R1 acting as a safeguard to protect the LED. For dynamic adjustment of the LED activation threshold, a variable (tuning) resistor can be employed for R2. As the resistance of the tuning resistor increases, a higher LDR resistance is required to achieve the necessary voltage for transistor activation and LED illumination, indicating a lower light level.For an alternative approach, a differential voltage input (from an LDR or other sources) can be utilized in conjunction with an operational amplifier for switching, as opposed to a single transistor.To facilitate the reading of this voltage value, an Arduino microcontroller has been incorporated into the circuit. -

The BJT delivers analog data, which is then monitored through microcontrollers. Utilizing the user-friendly Arduino UNO board and IDE was a deliberate choice for its simplicity. The circuit schematic has been implemented using Proteus, enabling a comprehensive simulation. The interface also accommodates various microcontrollers such as Arduino, STM32, etc., rendering the project highly adaptable and programmable.To integrate the Arduino code into the simulation, the compiled code with a .hex extension is copied. Subsequently, the file location is added to the Arduino UNO board on Proteus, allowing for the configuration of the system with the programmed code. This seamless process facilitates the simulation of the system based on the code written.For visualization of simulation results, the Virtual Terminal has been employed. This platform provides a clear representation of the outcomes and aids in the effective observation and analysis of the system's behavior.



Şekil 6 LUX-Meter Cicuit in Proteus

Component Number	Components	Quantity
1	Resistor-20kΩ	1
2	Resistor-10kΩ	1
3	BJT P2N2222A	1
4	LDR	1
5	Arduino UNO	1

Electrical characteristics

Parameter	Conditions	Min.	Typ.	Max.	Units
Cell resistance	10 lux 100 lux	20 -	- 5	100 -	kΩ kΩ
Dark resistance	10 lux after 10 sec	20	-	-	MΩ
Spectral response	-	-	550	-	nm
Rise time	10ftc	-	45	-	ms
Fall time	10ftc	-	55	-	ms

Figure 4 **Resistance as a function illumination**

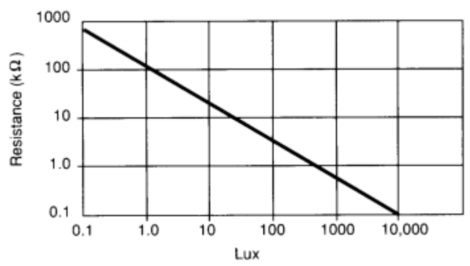


Figure 5 **Spectral response**

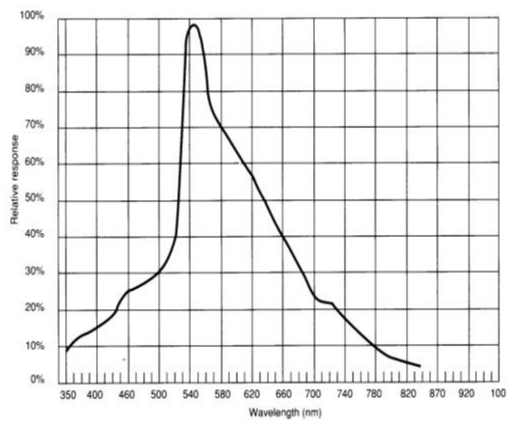


Figure 7 : LDR Information from Datasheet

```
const float slope = 0.1;
const float yIntercept = 10;

void setup() {
  Serial.begin(9600);
}

void loop() {
  int adcValue = analogRead(A0);
  float luxValue = slope * adcValue + yIntercept;
  Serial.println("Lux: " + String(luxValue));
  delay(100);
}
```

Figure 8 : Arduino Code

Simulation results;

All possible simulation results are shown below.

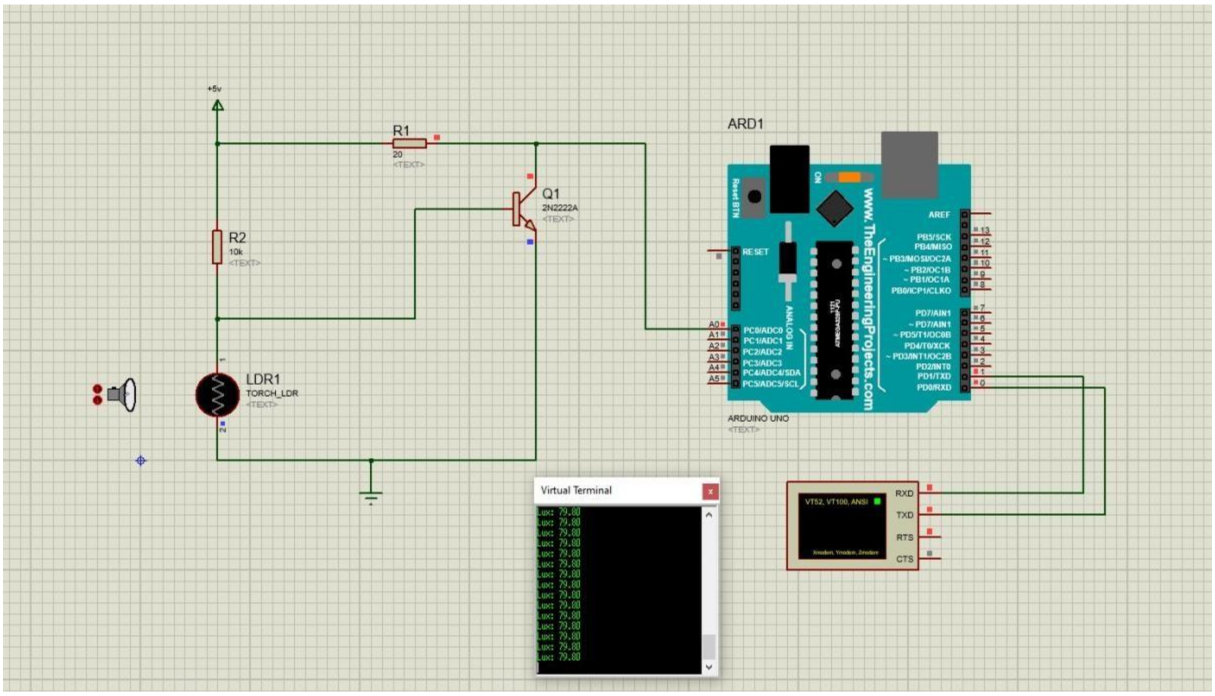


Figure 10;

In this project, it is observed that the dynamically changing lumen value of the LED, measured with the help of Arduino, corresponds to the increasing exposure to light. With each image, as the light is brought closer to the LED, there is a noticeable increase in the lumen value. Arduino continuously reads the lumen value of the LED using a sensor, detecting these changes and displaying the values on the screen.The outcomes of this project indicate that as the LED gets closer to the light source, the lumen value increases. In each image, the significant enhancement in the brightness of the LED is accompanied by an observed rise in the measured lumen value. The success of the project lies in Arduino's ability to continuously read and display these dynamic changes in response to varying light conditions, showcasing the adaptability and functionality of the designed lighting control system.

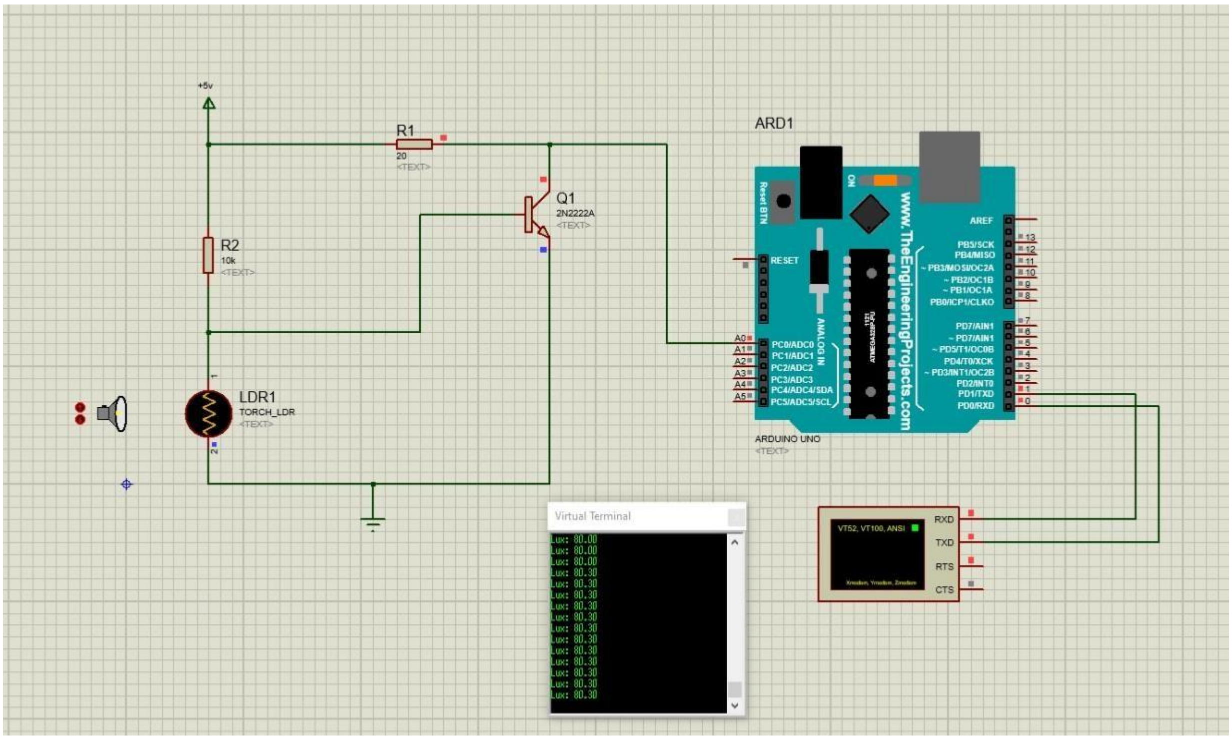


Figure 11,

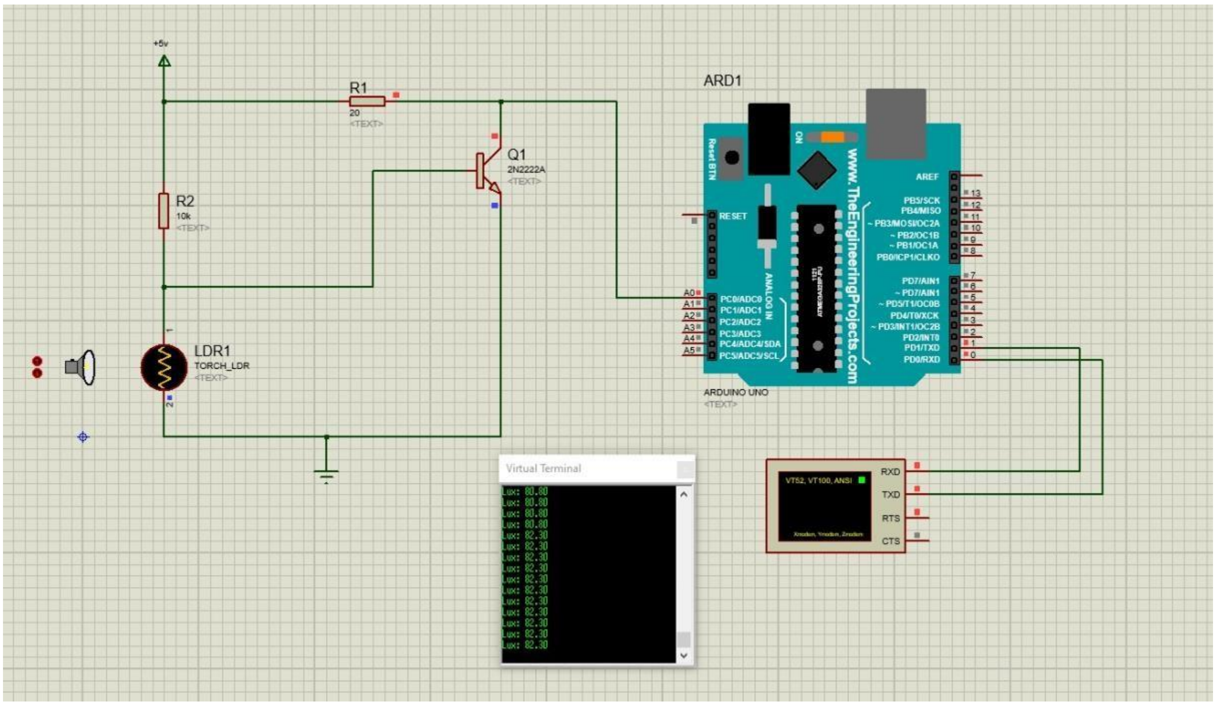


Figure 12,

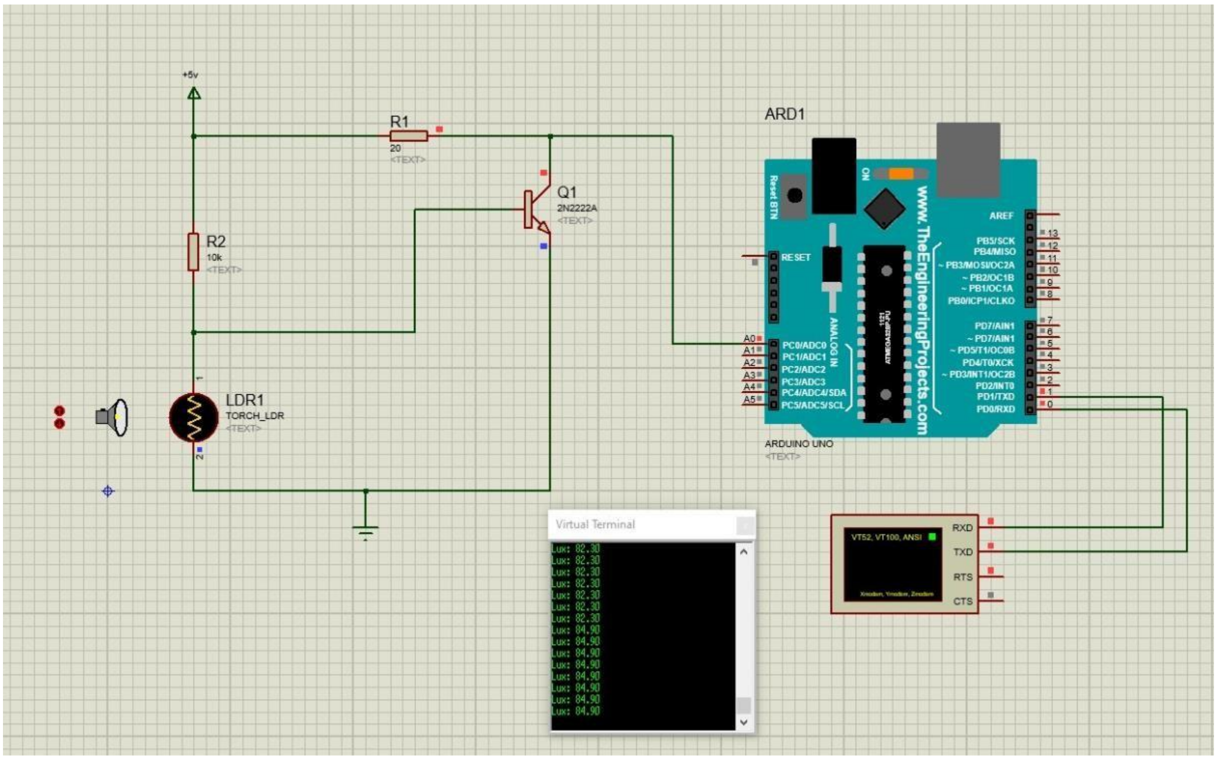


Figure 13:

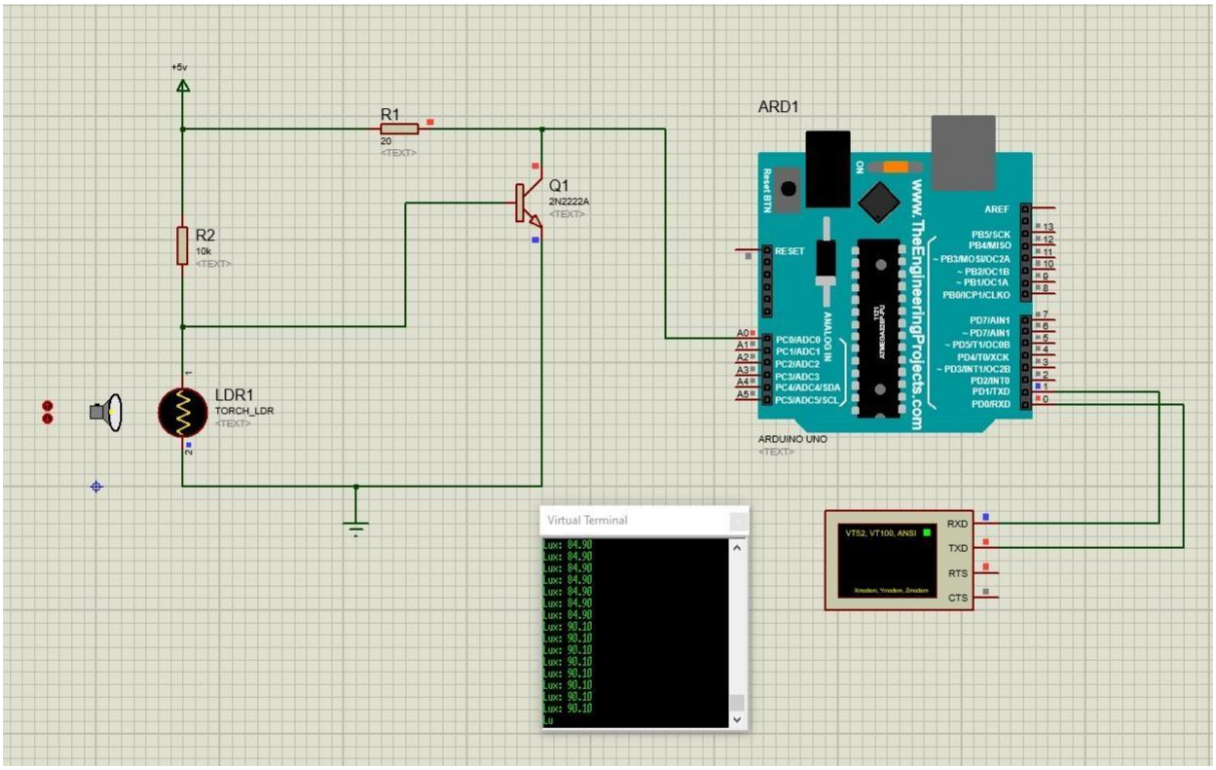


Figure 14

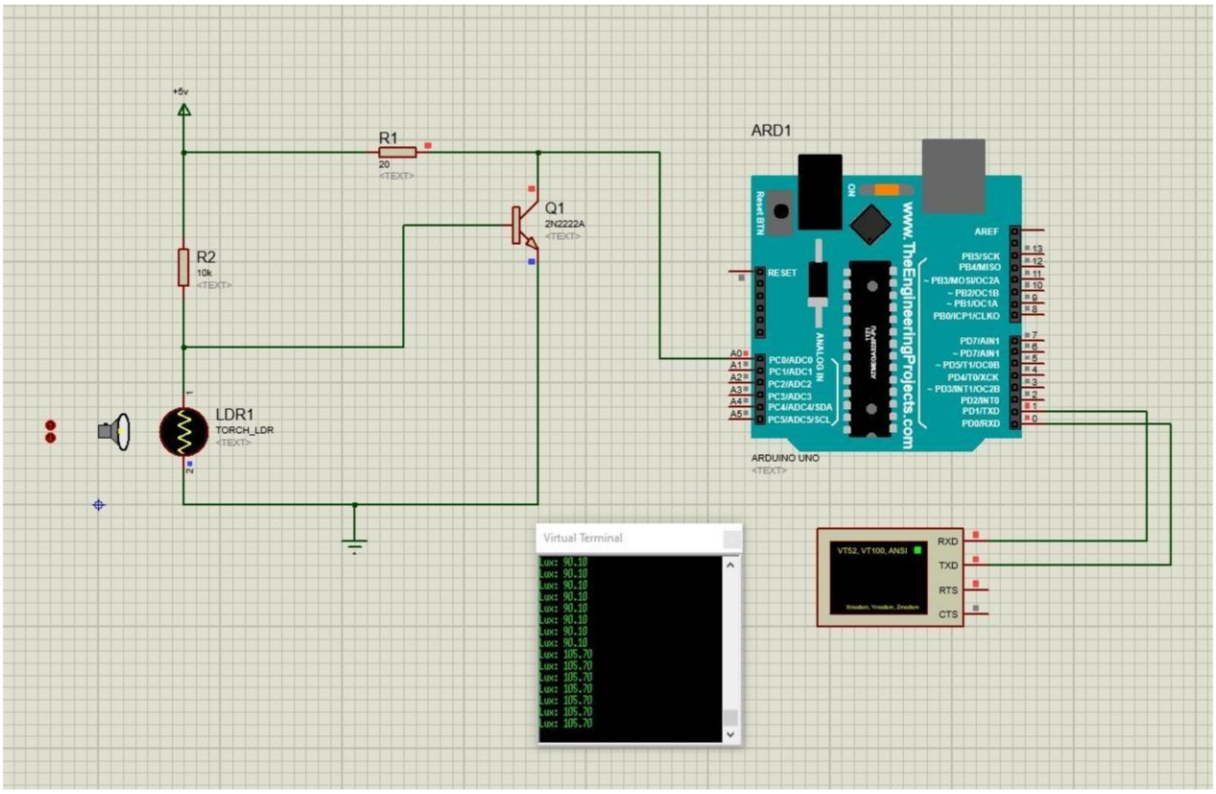


Figure 15

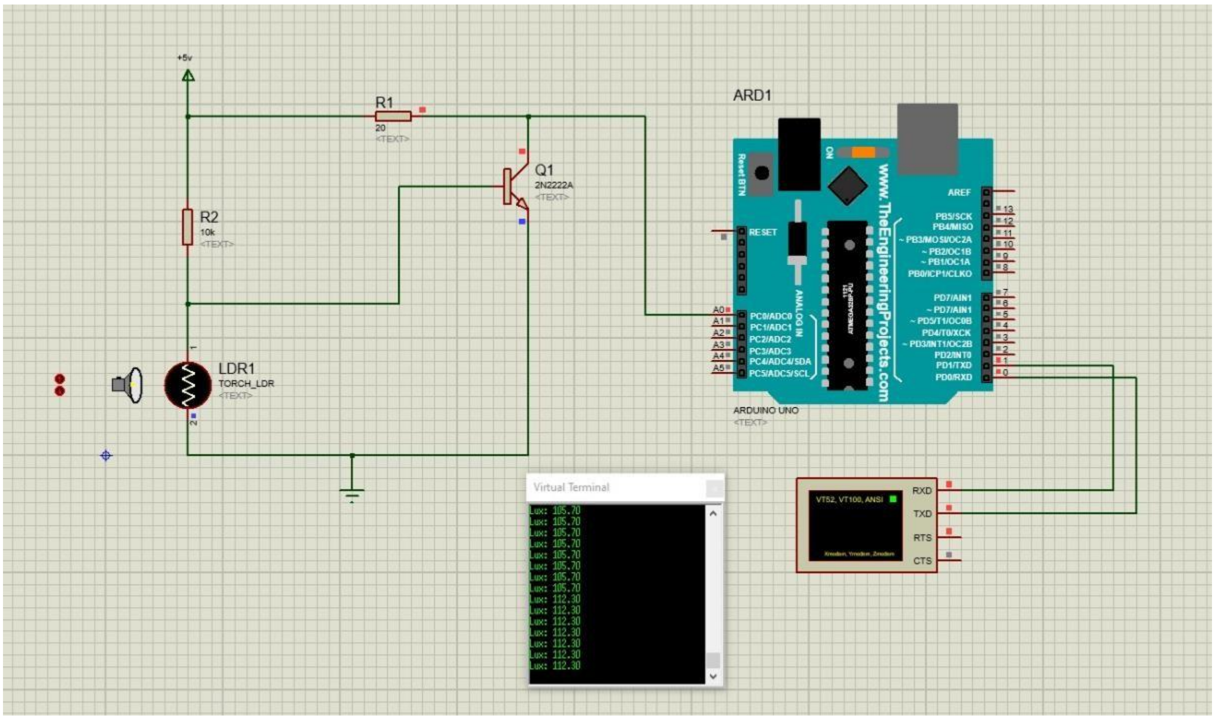


Figure 16

Result

Taking into account the observed lumen values in this project, it is possible to understand the variations in each image. The lumen value in the first image is determined to be 79.8. This initial value consistently increases with subsequent increments in light exposure. In the second image, the lumen value rises to 80.30, followed by 82.30 in the third image, 84.90 in the fourth, 90.10 in the fifth, 105.70 in the sixth, and finally, 112.30 in the seventh.Analyzing these values reveals a pronounced sensitivity of the LED to light, especially as it approaches the light source. The continuous increase in the value from the first image onwards indicates the successful operation of the LDR and Arduino integration within the system. The primary goal of this project was to demonstrate the technique of creating a digital lux meter using a simple LDR.

References

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