CEC Continuing Education Center

DesignNews

Hands-On with Industry 4.0 using the Raspberry Pi and the Arduino Platforms

DAY 2: A Conceptual Industry 4.0 Test Circuit Part 1 – Wireless Sensing

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Webinar Logistics

- Turn on your system sound to hear the streaming presentation.
- If you have technical problems, click “Help” or submit a question asking for assistance.
- Participate in ‘Attendee Chat’ by maximizing the chat widget in your dock.

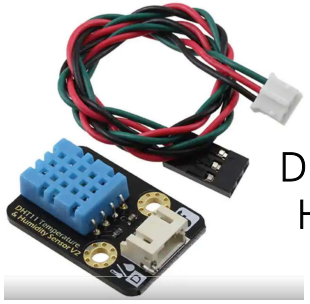
Dr. Don Wilcher

Visit ‘Lecturer Profile’ in your console for more details.

Course Kit and Materials

IRFS630A N-Channel PMOSFET

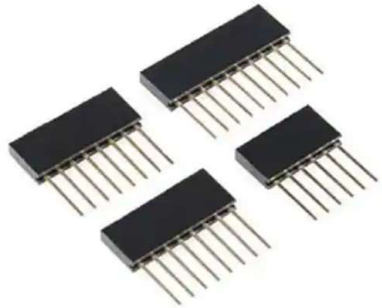
Axial DC Fan, 5VDC

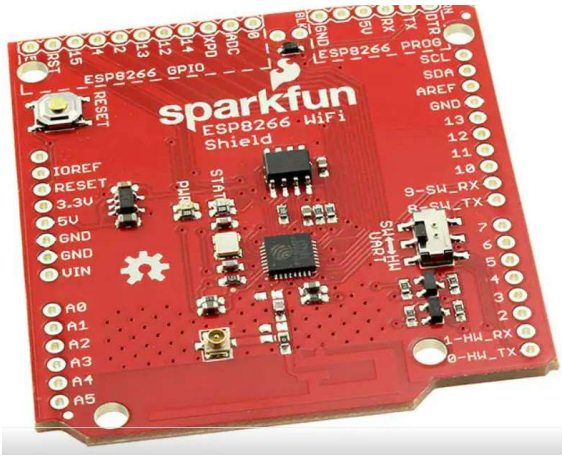


DHT Temperature-Humidity Sensor

Osoyoo WiFi Internet of Things Learning Kit

Arduino Stackable Header Kit





ESP8266 WiFi Shield

Agenda:

- Cyber-Physical Systems Model
- Light Sensor Basics
- Light Sensor Circuits
- Lab: Wireless Light Sensor

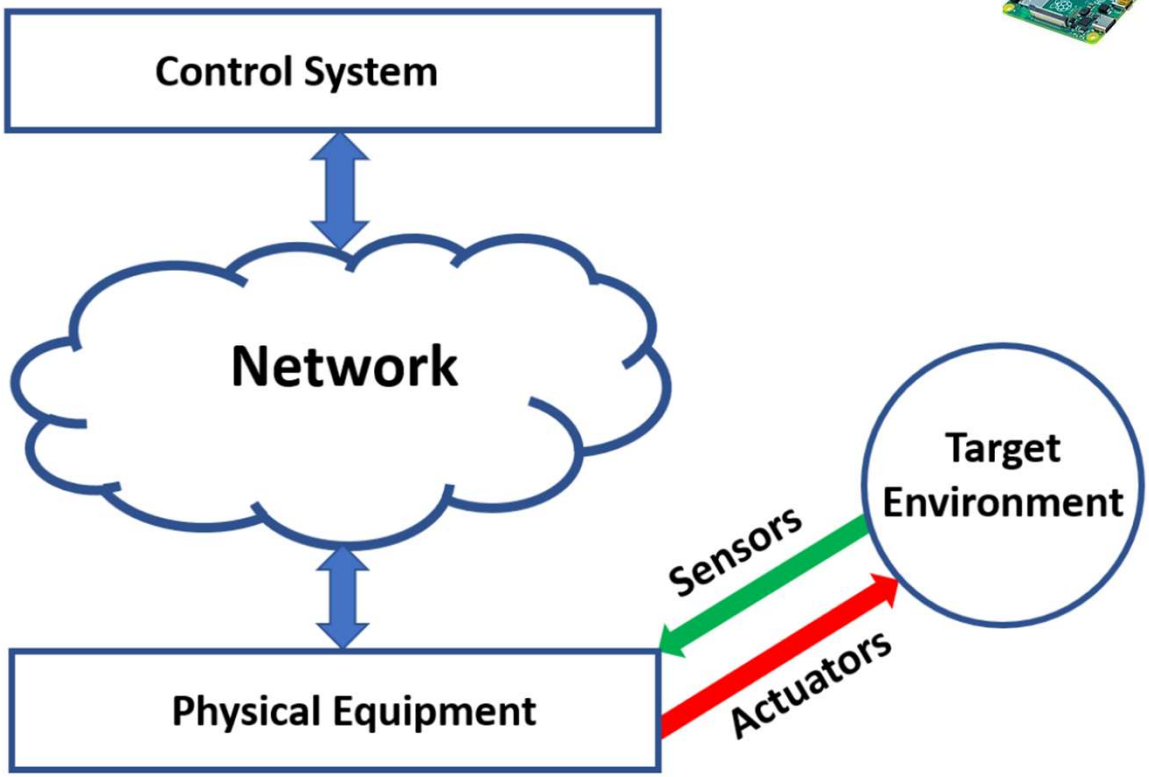
Industry 4.0:

" Over the last two decades, there has been massive progress in the fields of information technology, automation, robotics, Big Data, sensor technology (Internet of Things) and Artificial Intelligence (Russmann et al. 2015). These technological advances may be interpreted as prerequisites for the increasingly popular concept of Industry 4.0, which refers to the current trend of digitalization, automation, and data exchange in manufacturing (Kagermann et al., 2013; Schwab, 2016)."

CPS System Model

"CPS is an engineering system designed to control and operate physical processes through computers" (Mughees, 2020).

The Model provides a hands-on framework for exploring CPS System Concepts using Physical Computing Techniques. Design Opportunities!!



Question 1

In reviewing slide 7, sensors provide noise from the Target Environment to the Physical Equipment.

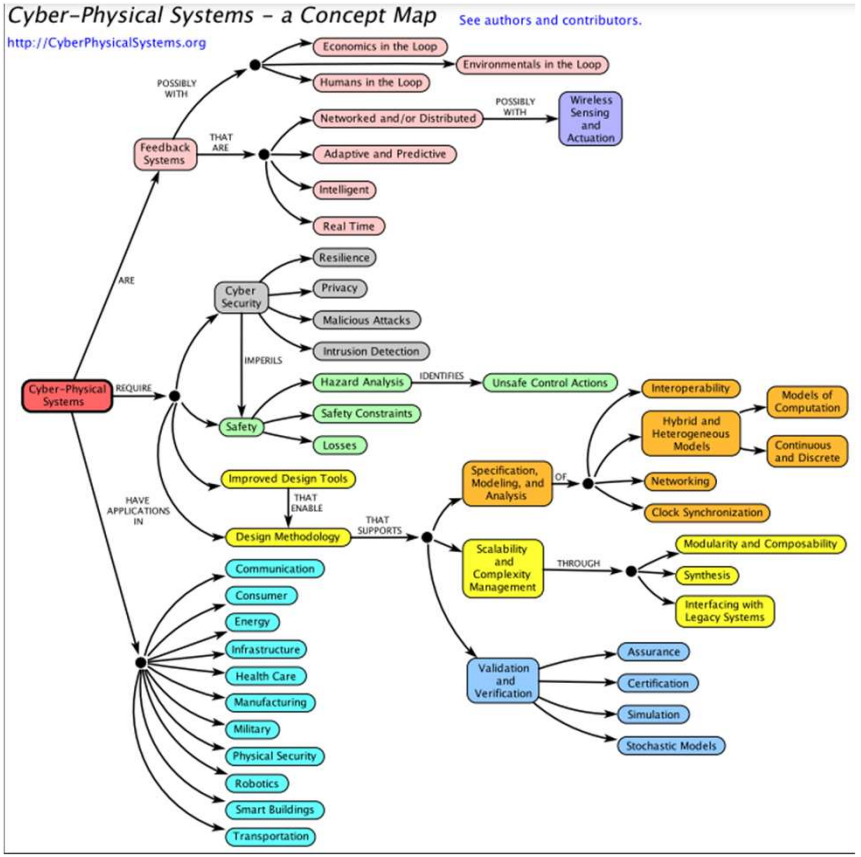
a) True

b) False

CPS Concept Map

Image courtesy of:

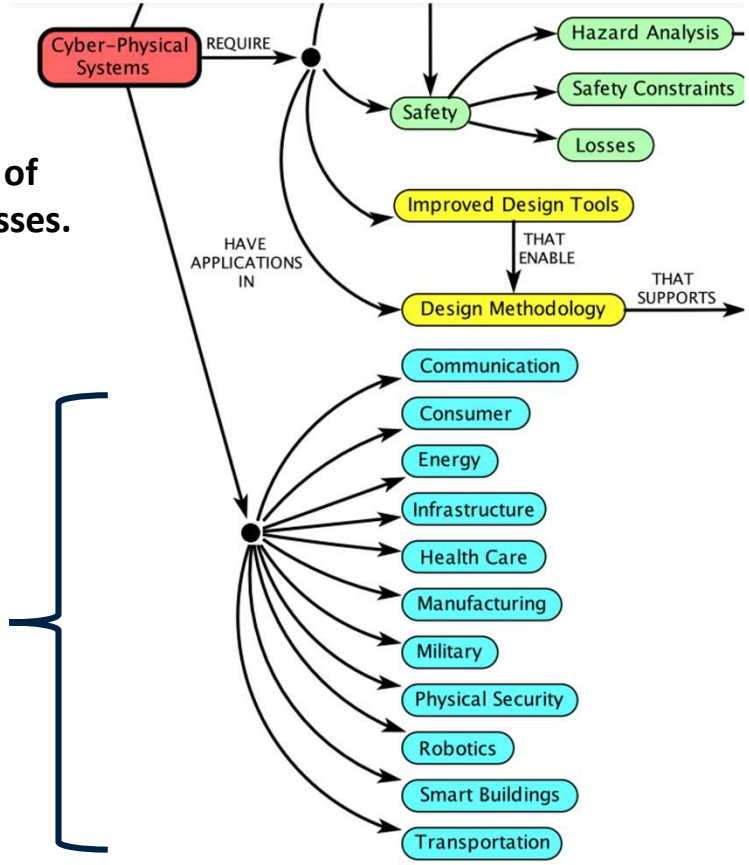
https://ptolemy.berkeley.edu/projects/cps/



CPS Concept Map. . .

https://ptolemy.berkeley.edu/projects/cps/

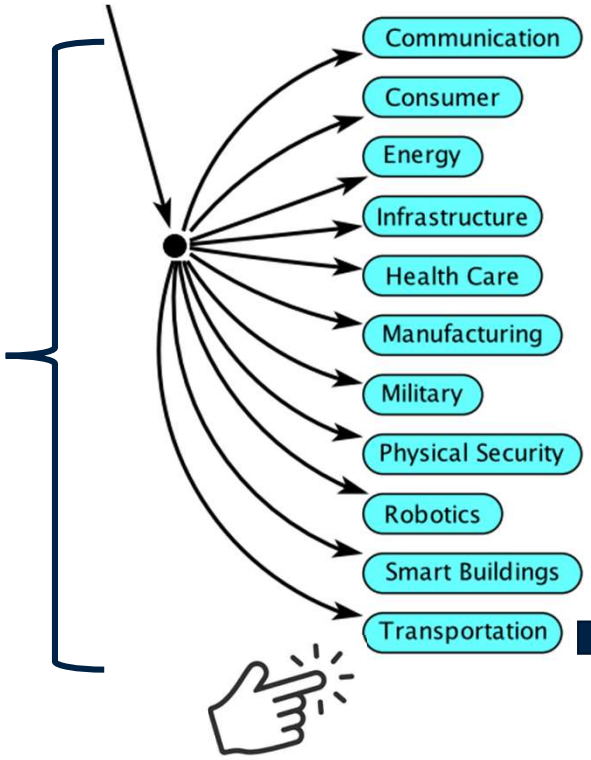
Cyber-Physical Systems (CPS) are integrations of computation, networking, and physical processes.



CPS Applications: Opportunities!

CPS Concept Map. . .

Nodes are Interactive!



Application Description

Transportation

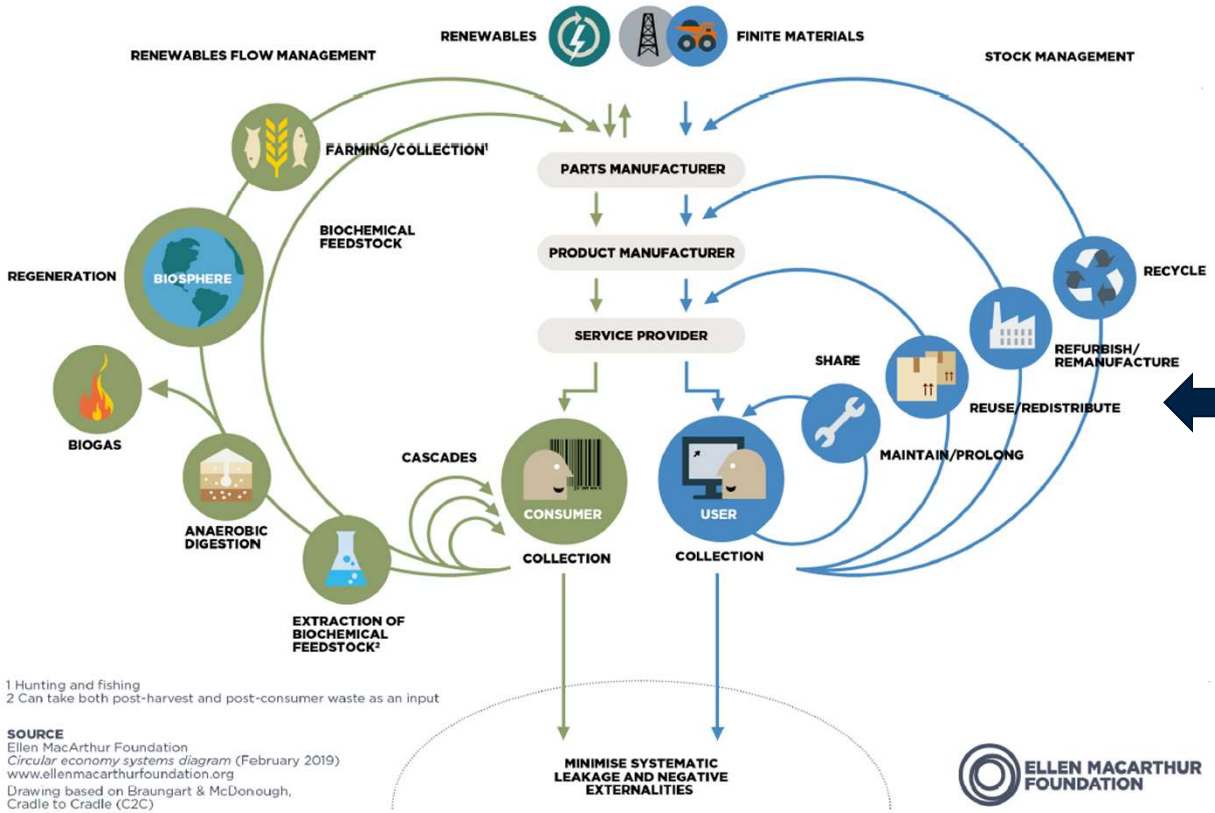
Transportation applications of CPS include:

- automotive systems;
- avionics and aerospace;
- elevators, escalators, and moving sidewalks;
- railroads; and
- traffic management.

Major issues transportation system design include safety, efficiency, and response to emergencies and disasters.

CPS Concept Map. . .

Circular Economy: Butterfly Diagram

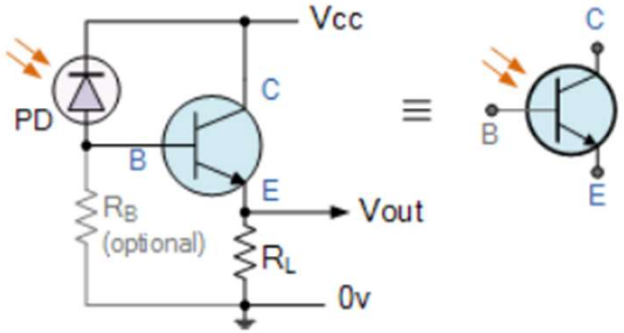


CPS Alignment

Light Sensor Basics

What is a light sensor? Definitions and descriptions

Light sensors are also known as photoelectric devices or photo sensors because they convert light energy (photons) into electricity (electrons).



Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Light Sensor Basics. . .

Photoelectric devices can be grouped into two main categories

a) Photo-voltaic or Photo-emissive – generate electricity when illuminated
b) Photo-resistive or Photo-conductive – Change electrical properties when illuminated

Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Light Sensor Basics. . .

Photoelectric devices can be grouped into two main categories

Photo-voltaic or Photo-emissive:
Electrical Symbol

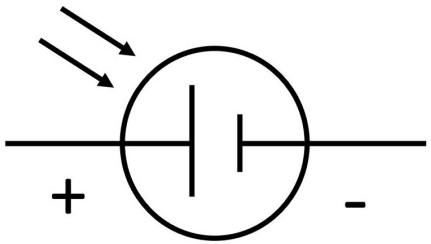
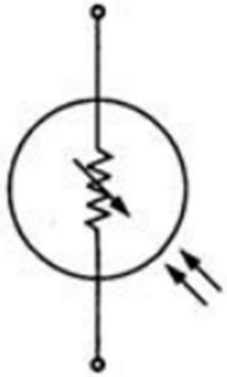


Photo-resistive or Photo-conductor:
Electrical Symbol



Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Light Sensor Basics. . .

Speaking of Photo-resistive or Photo-conductive components:

- The commonly used material to manufacture photo-resistive or photo-conductive components is Cadmium Sulfide (CdS). The main reasons:
  a) the spectral response matches the human eye
  b) can easily be detected using a simple light source like a light bulb.
  c) CdS has a peak sensitivity wavelength (λp) of 560nm to 600nm.
- The light-dependent resistor (LDR) is a CdS-based photo-conductive resistor commonly used as a basic light sensor.
- The LDR light sensor is a passive device.

Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Question 2

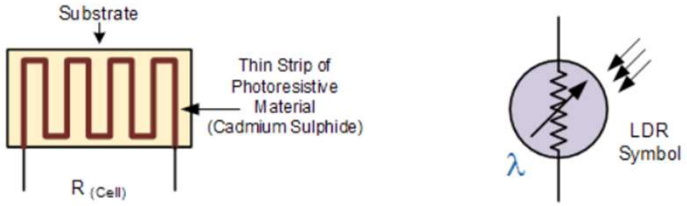
A LDR light sensor is_____

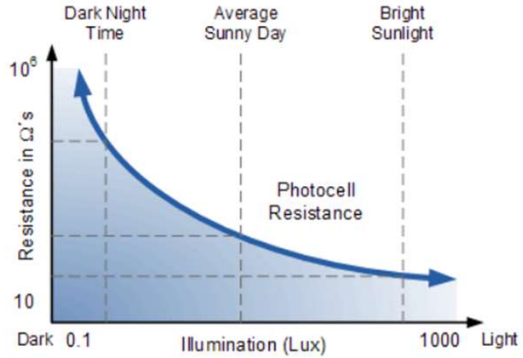
a) a passive device
b) an active device
c) a semiconductor device
d) None of the above

Light Sensor Circuits

Speaking of Photo-resistive or Photo-conductive components:

LDR characteristic curve, substrate material, and electrical symbol elements



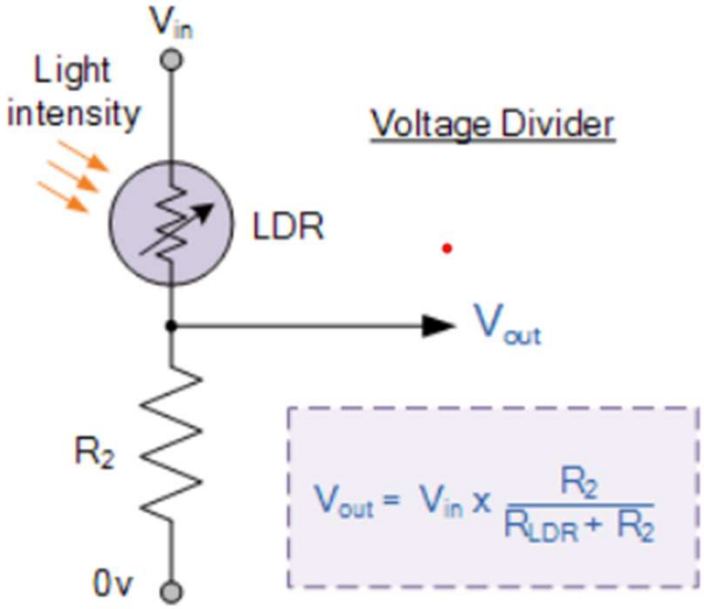


Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Light Sensor Circuits. . .

A Basic Light Detection Circuit

Basic Circuit Operation:
Low Light Intensity → <Vout
High Light Intensity → >Vout



Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Question 3

A light-dependent resistor (LDR) is

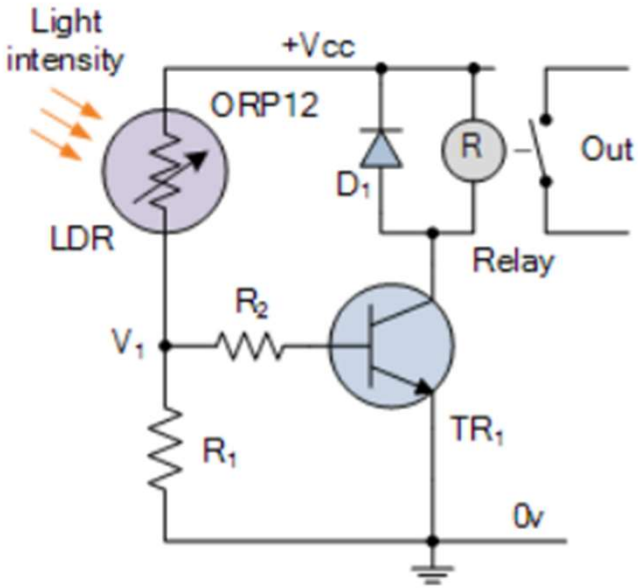
a) CdS based photoconductive component

b) CdS based photovoltaic component

c) CdS based photoelectric component

Light Sensor Circuits. . .

A Basic Light Detection Switch Circuit

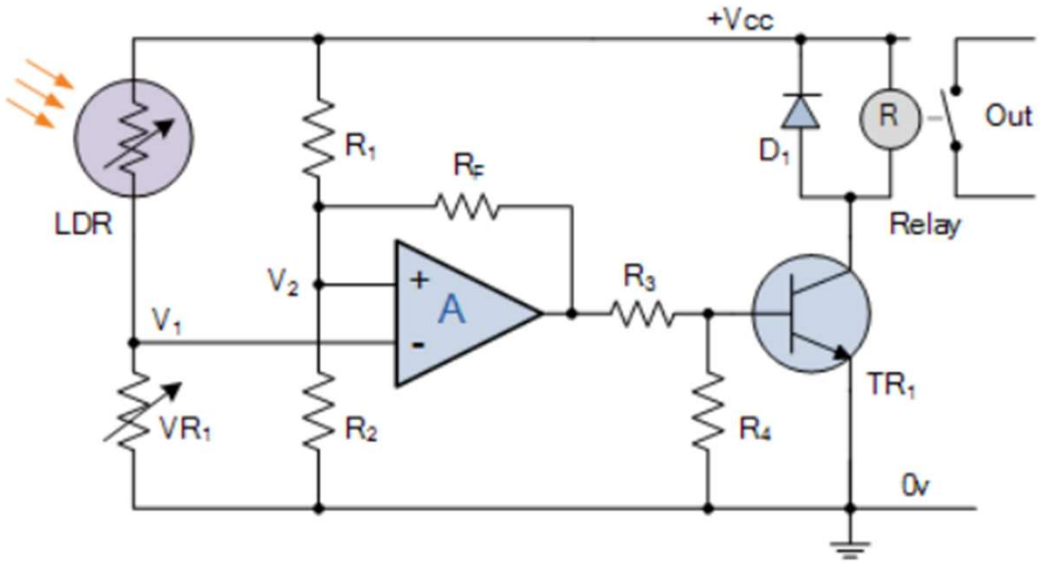


Basic Circuit Operation:
Low Light Intensity → TR Switch is OFF
High Light Intensity → TR Switch is ON

Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Light Sensor Circuits. . .

A Light Level Sensing Circuit

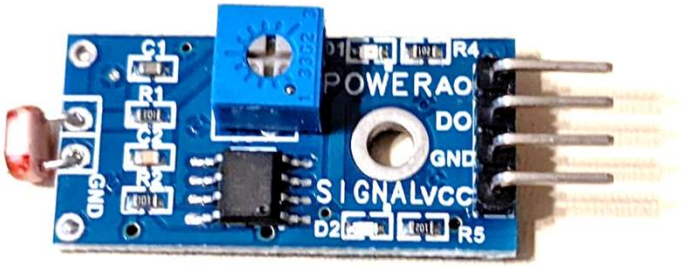


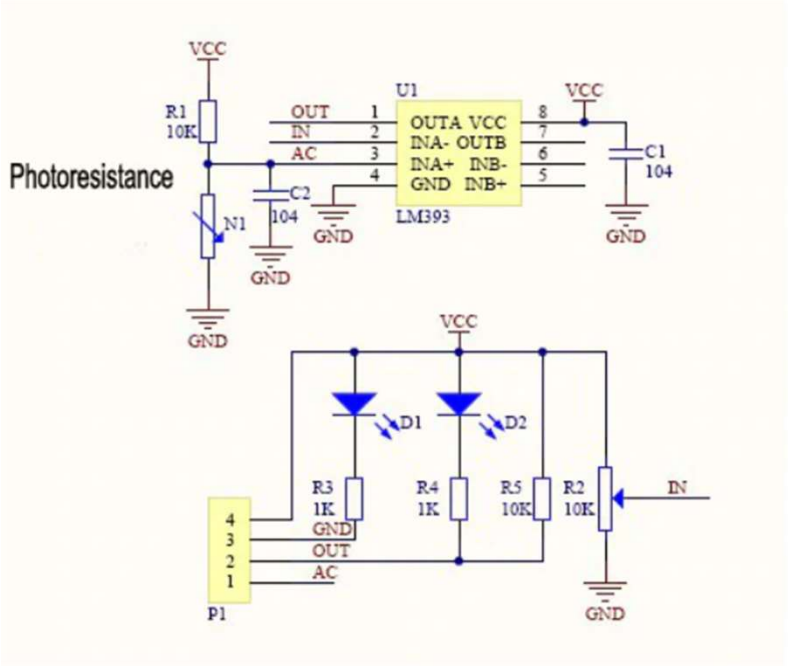
Basic Circuit Operation:
When the light level sensed by the LDR and its output voltage falls below the reference voltage set at V2, the output from the op-amp changes state, activating the relay and switching the connected load.

Source: ElectronicsTutorial. (2021). *Light sensors. https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

Light Sensor Circuits

Photoresistor Sensor Module

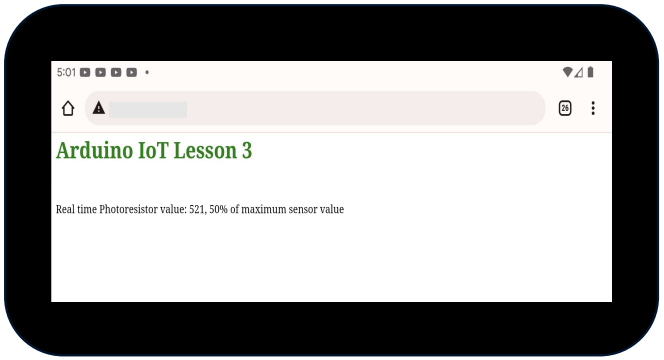


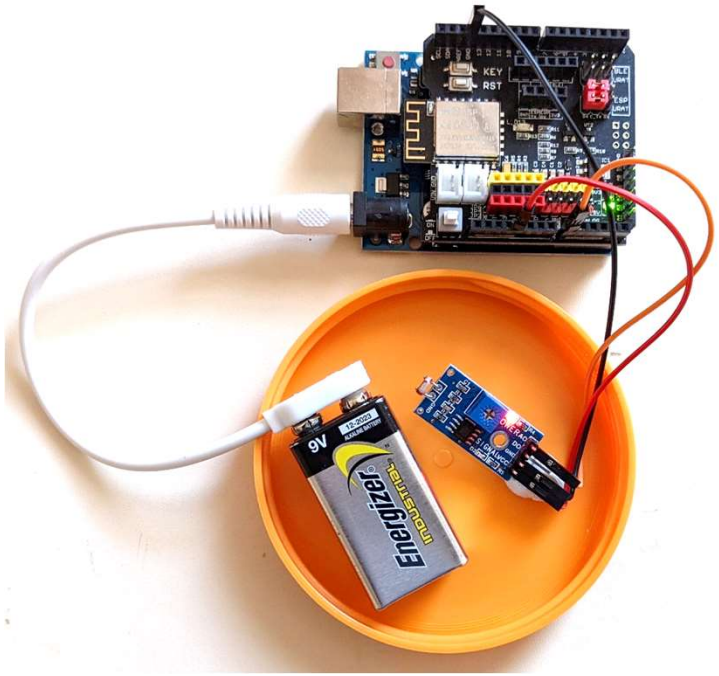


Basic Circuit Operation:

The photoresistor sensor module behaves like a typical light-level sensing circuit. The sensitivity of the Photoresistor Sensor Module can be adjusted with the potentiometer (N1).

Lab: Wireless Light Sensor





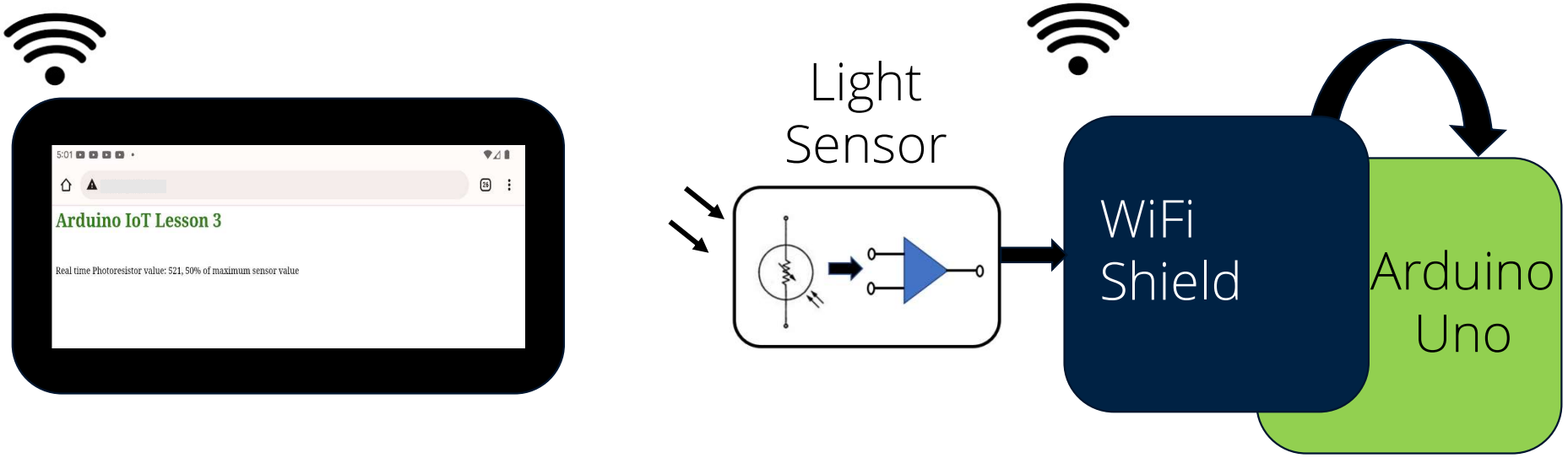
Lab: Wireless Light Sensor

Learning Objectives:

- Participants will learn to use a WiFi Shield with an Arduino Uno or Compatible.
- Participants will learn to use an Arduino Compatible as a wireless light sensor.
- Participants will learn how to adjust a light sensor to behave in analog mode.

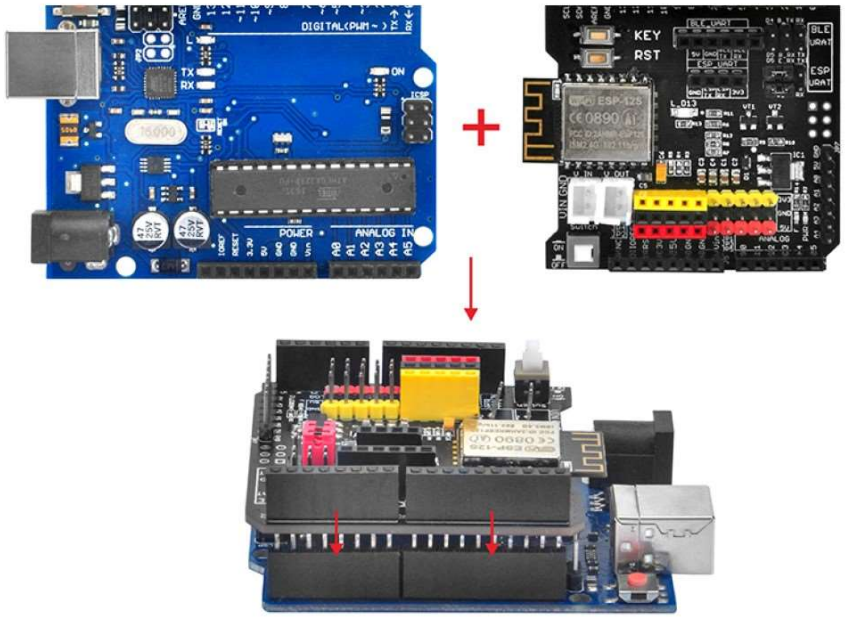
Lab: Wireless Light Sensor. . .

Lab Setup Concept



Lab: Wireless Light Sensor. . .

Lab Setup: Attaching WiFi Shield to the Arduino Compatible



Notes:

a) Attach the IoT unit to your development machine

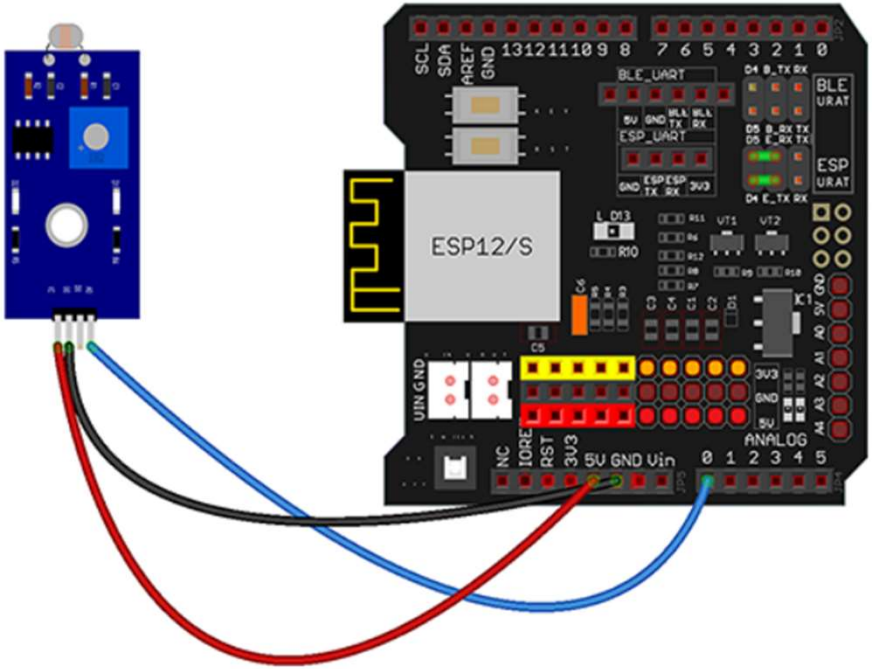
b) Connect your Arduino Compatible to the correct COM port

Lab: Wireless Light Sensor. . .

Lab Setup: Wiring the Light Sensor to the IoT unit

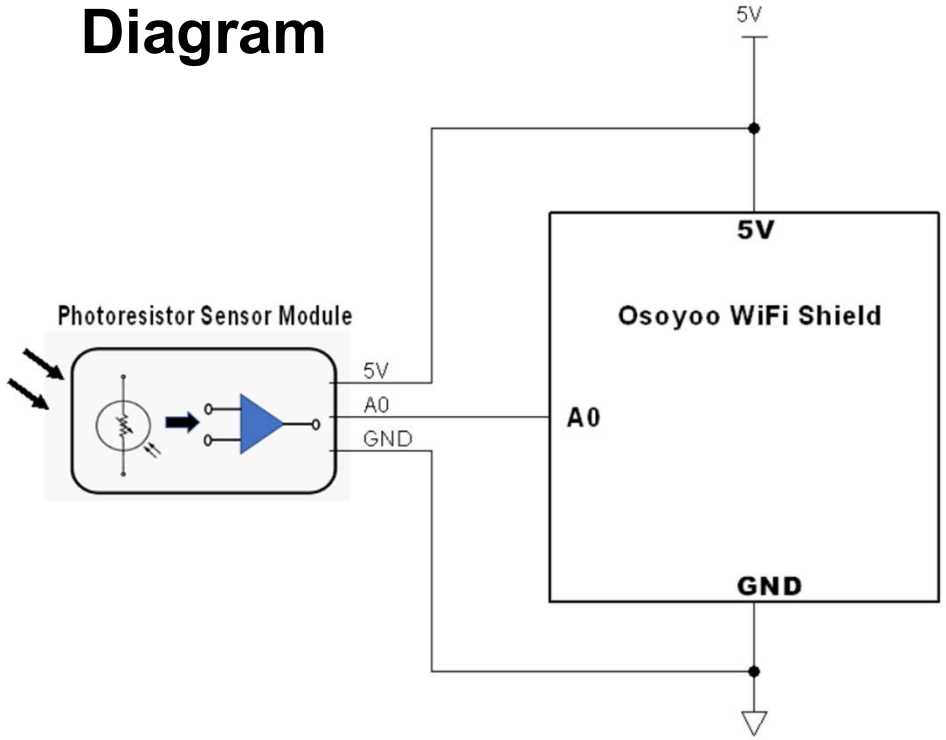
Note:

The photo-resistor sensor module is the light sensor.



Lab: Wireless Light Sensor. . .

Lab Setup: IoT Receiver Electronic Circuit Schematic Diagram

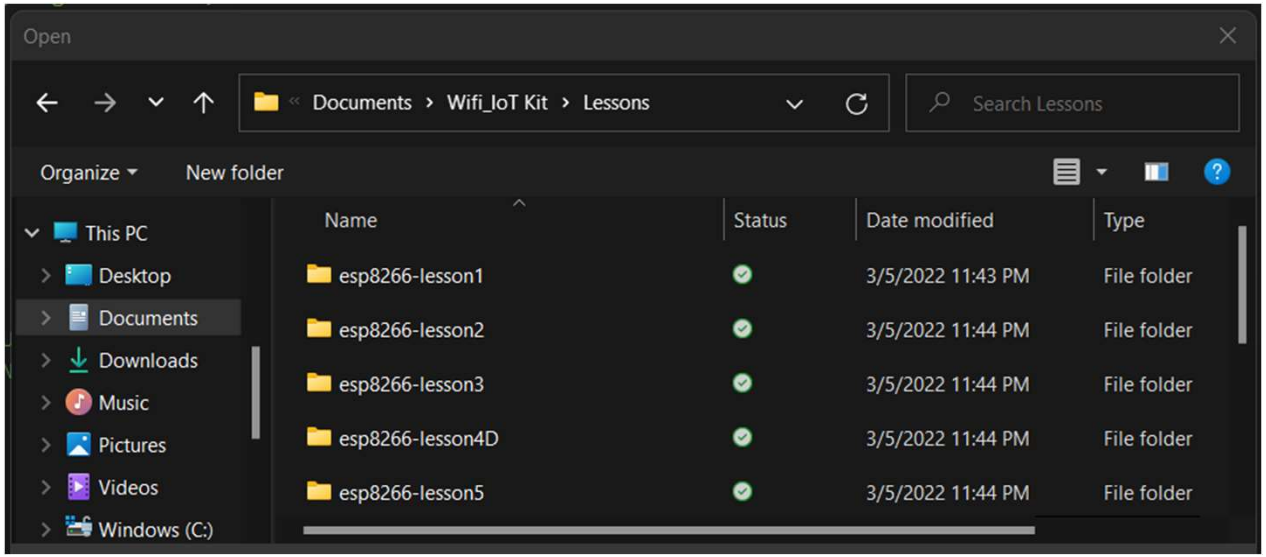


Lab: Wireless Light Sensor. . .

Lab Setup: Upload Lesson 3 code to Arduino Compatible

Download the code from here!

WiFi Internet of Things Learning Kit for Learn Coding with Arduino IDE 3: Photoresistor Sensor « osoyoo.com



Question 4

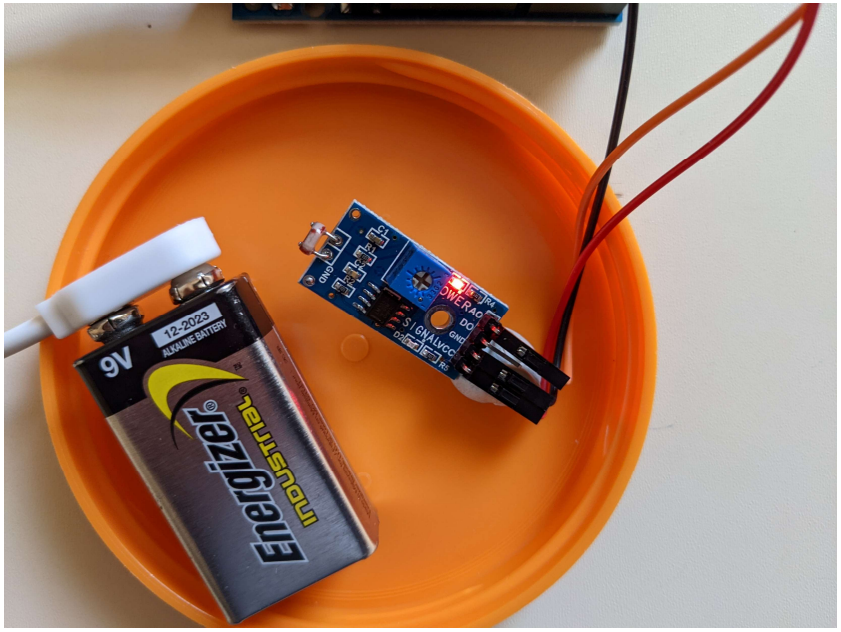
What laboratory lesson will be uploaded to the Arduino Uno or compatible?

a) 3
b) 2
c) 1
d) None of the above

Lab: Wireless Light Sensor . . .

Lab Setup: Adjust the Photoresistor sensor module's potentiometer

Adjust the potentiometer with a screwdriver until the green LED turns off.



Lab: Wireless Light Sensor . . .

Lab Setup: Upload Lesson 3 code to Arduino Compatible

Arduino IoT Lesson 3

Light Detection Reading

Real time Photoresistor value: 125, 88% of maximum sensor value

Lab: Wireless Light Sensor . . .

Lab Setup: Upload Lesson 3 code to Arduino Compatible

Dark Detection Reading

```
Arduino IoT Lesson 3

Real time Photoresistor value: 979, 5% of maximum sensor value
```

Lab: Wireless Light Sensor . . .

Play with the Code!

```
Line 25:Change the analog Pin
const int analogInPin = A0;  // Analog input pin that the photoresistor is attached to

Line 79: Change the Header and Font size
msg +="<HTML><head><meta http-
equiv=\"refresh\" content=\"5\"></head><BODY><H1 style=\"color:green;\">Arduino IoT Lesso
n 3</H1><br>";
```

Question 5

In reviewing slide 35, what line of instruction would allow attaching an external sensor to another analog pin?

a) Line 25

b) Line 79

Thank you for attending

Please consider the resources below:

ElectronicsTutorial. (2021). Light sensors. *https://www.electronics-tutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,)%20into%20electricity%20(electrons)*

ESP8266 Hardware Design Guidelines: https://www.espressif.com/en/support/documents/technical-documents

Kagermann, H., Wahlster, W., & Helbig, J. (2013). *Recommendations for implementing the strategic initiative Industrie 4.0: Securing the future of German manufacturing industry*. https://www.din.de/blob/76902/e8cac883f42bf28536e7e8165993f1fd/recommendations-for-implementing-industry-4-0-data.pdf

Mughees, A. (Sept 05, 2020). *Discrete and process automation: From cyber-physical systems to pervasive intelligence*. https://electronics360.globalspec.com/article/15647/from-cyber-physical-systems-to-pervasive-intelligence

Osoyoo Website. (2022). WiFi iot learning kit. https://osoyoo.com/2020/05/30/wifi-iot-learning-kit-for-Arduino/

Russamann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engle, P., & Hanrisch, M. (2015). *Industry 4.0 – The future of productivity and growth in manufacturing industries*. The Boston Consulting Group.

Schwab, K.(2016). *The fourth industrial revolution.* Penguin Random House.

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