

CEC

Continuing
Education
Center

DesignNews

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

DAY 5: Build a Raspberry Pi Node-RED Dashboard: Part 2-Temperature-Humidity Sensing

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Webinar Logistics

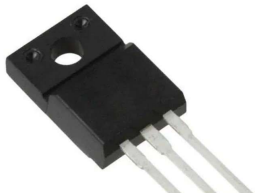
- Turn on your system sound to hear the streaming presentation.
- If you have technical problems, click “Help” or submit a question asking for assistance.
- Participate in ‘Attendee Chat’ by maximizing the chat widget in your dock.



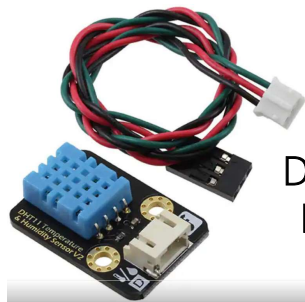
Dr. Don Wilcher

Visit 'Lecturer Profile' in your console for more details.

IRFS630A N-Channel PMOSFET



Axial DC Fan, 5VDC



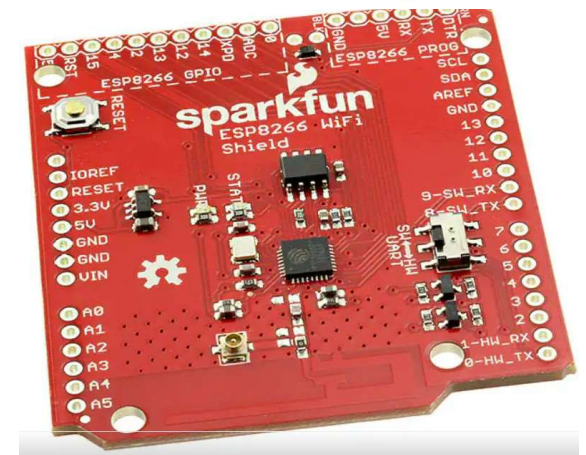
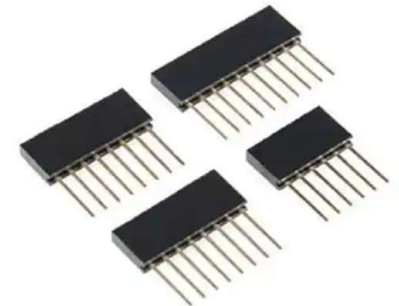
DHT Temperature-
Humidity Sensor

Course Kit and Materials



Osoyoo WiFi Internet of Things
Learning Kit

Arduino Stackable Header Kit



ESP8266 WiFi Shield

Agenda:

- Cyber-Physical Systems Model
- What is a DHT11 Sensor
- Modeling a Humidity Sensor using ChatGPT
- Lab: Node-RED Temperature-Humidity Sensing Monitor



Industry 4.0:



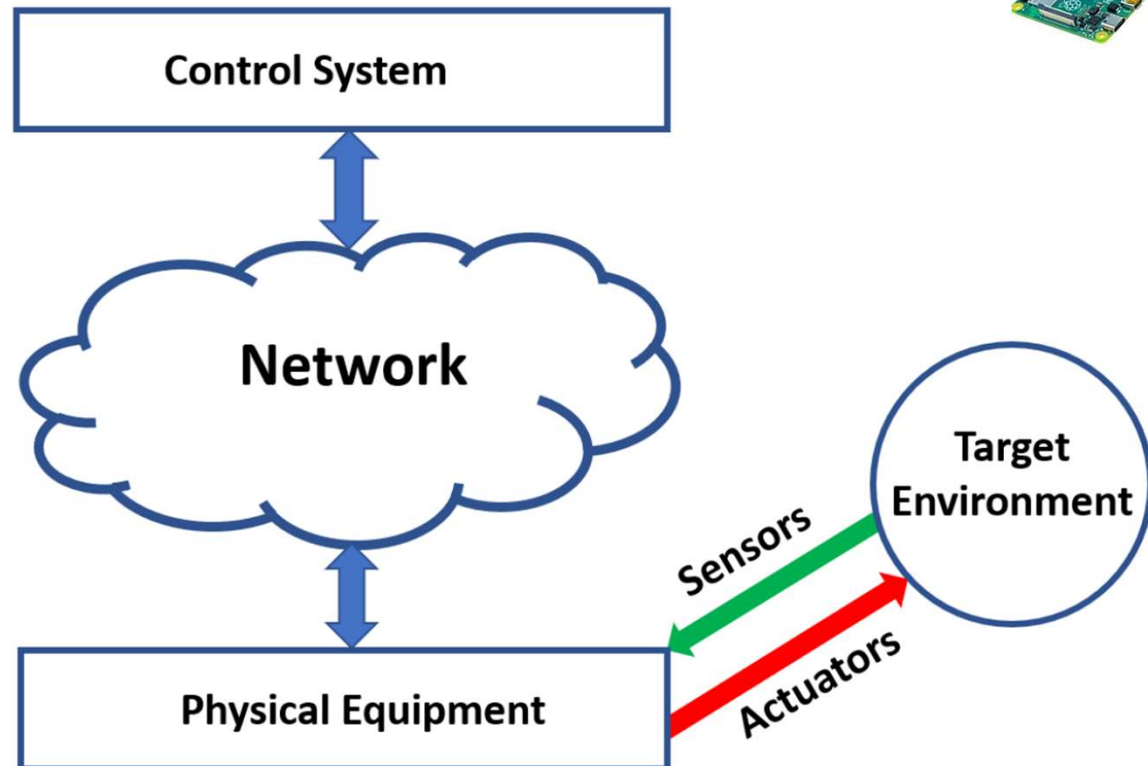
“ Over the last two decades, there has been massive progress in the fields of information technology, automation, robotics, Big Data, sensor technology (Internet of Things) and Artificial Intelligence (Russmann et al. 2015). These technological advances may be interpreted as prerequisites for the increasingly 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 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!!

CPS System Model



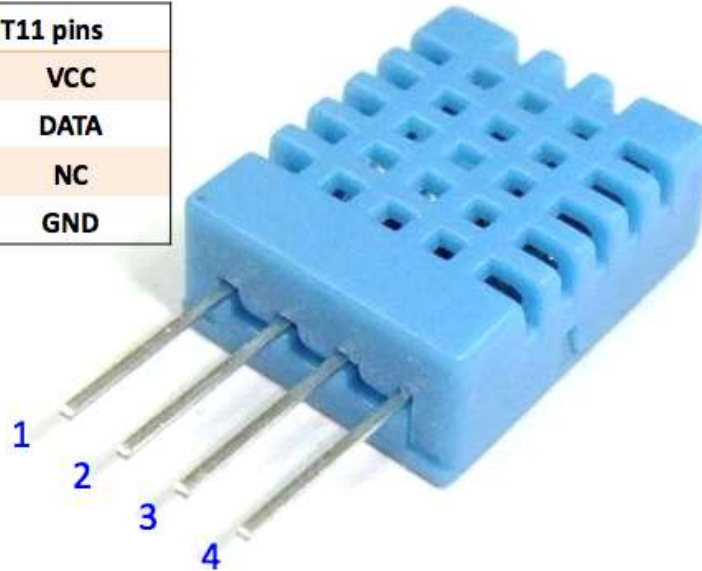
What is a DHT11 Sensor?



- A low-cost digital temperature and humidity sensor.
- The sensor consists of a
 - a) capacitive humidity
 - b) thermistor
- A capacitive humidity sensor and thermistor measure the surrounding air.
- A digital signal is provided on the data pin of the sensor

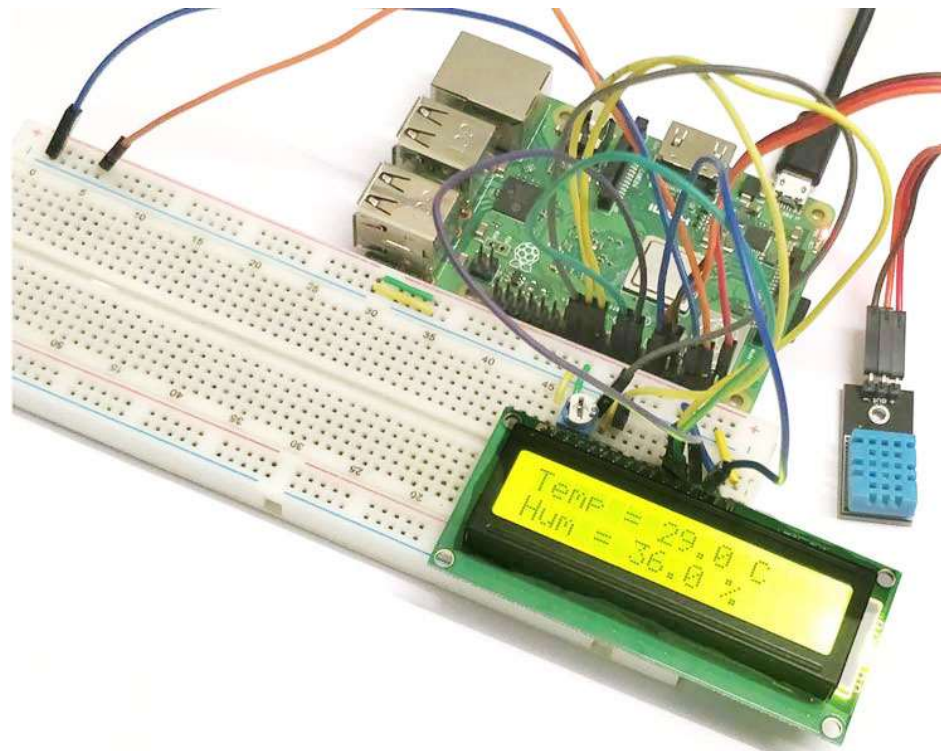
What is a DHT11 Sensor?..

DHT11 pins	
1	VCC
2	DATA
3	NC
4	GND



What is a DHT11 Sensor?..

DHT11 sensor wired to a Raspberry Pi



Source: Yasin, S.(2019, February 6). *Using the dht11 sensor with raspberry pi to measure temperature and humidity.*
<https://electronicslovers.com/2019/02/using-the-dht11-sensor-with-raspberry-pi.html>

Question 1

On the DHT11 sensor, which pin provides the data to a microcontroller?

- a) 2**
- b) 3**
- c) 1**
- d) 4**

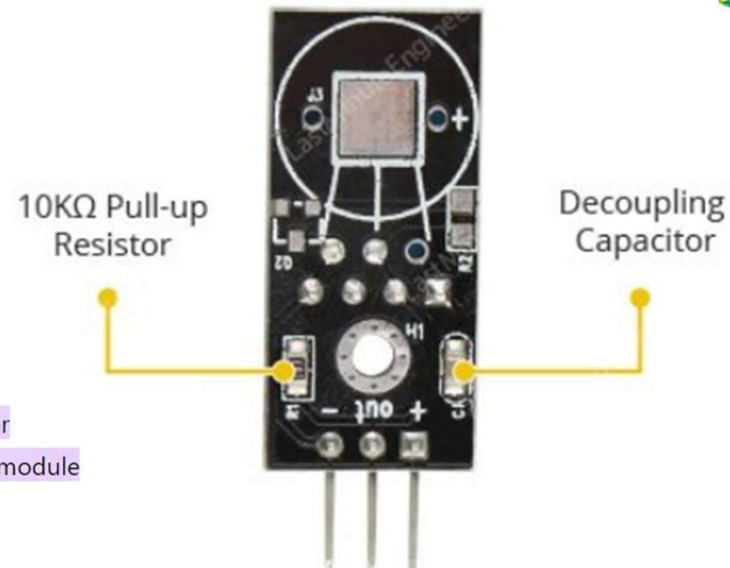


What is a DHT11 Sensor?..

Is a pullup resistor required for the DHT11 Sensor?

DHT11 sensors typically require an external 10K pull-up resistor on the output pin for proper communication between the sensor and the Arduino. However, because the module already includes a pull-up resistor, you do not need to add one.

The module also includes a decoupling capacitor for filtering power supply noise.



Source: Interface DHT11 Module With Arduino:

<https://lastminuteengineers.com/dht11-module-arduino-tutorial/#:~:text=DHT11%20sensors%20typically%20require%20an,for%20filtering%20power%20supply%20noise.>

Question 2

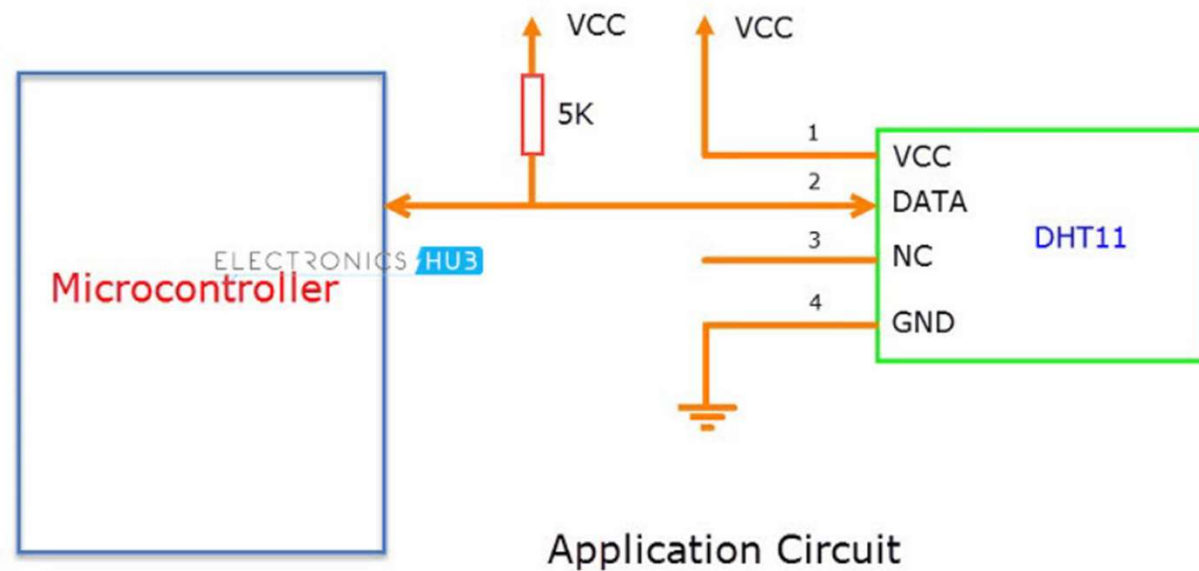
A pull-up resistor on the DHT11 sensor data pin(pin 2) does not provide proper communication between the sensor and the microcontroller.

- a) True**
- b) False**



What is a DHT11 Sensor?..

Is a pullup resistor required for the DHT11 Sensor?



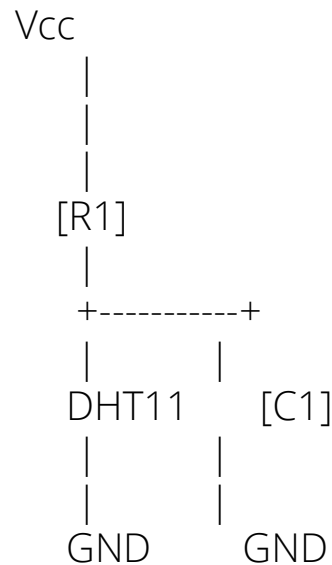
Source: <https://www.electronicshub.org/dht11-humidity-sensor-arduino/>

What is a DHT11 Sensor?..



Is a 10KΩ resistor required for the DHT11 Sensor?

ChatGPT Generated DHT11 Sensor Wiring Diagram with pullup resistor and decoupling Capacitor



```
yaml
Vcc
|
|
|
[R1]
|
+-----+
|
|
DHT11   [C1]
|
|
GND     GND
```

Source:

<https://lastminuteengineers.com/dht11-module-arduino-tutorial/#:~:text=DHT11%20sensors%20typically%20require%20an,for%20filtering%20power%20supply%20noise.>

What is a DHT11 Sensor? . . How Does It Work? . . .




- The DHT sensors are made of two parts, a capacitive humidity sensor, and a thermistor.
- There is also a basic chip inside does some analog-to-digital conversion and spits out a digital signal with the temperature and humidity.
- The digital signal is fairly easy to read using any microcontroller.



Ada, L. (2023, March 13). *Dht11, dht22, and am2302 sensors: Overview*. <https://learn.adafruit.com/dht/overview>

Modeling a Humidity Sensor Using ChatGPT



Include a plot function with the code to module the output response of the electrical circuit equation. Provide code to save the data in a csv file. 



Here is an updated version of the Python code that includes both the plot function and the code to save the data in a CSV file:  

Prompt Inquiry Question

Modeling a Humidity Sensor Using ChatGPT. . .



ChatGPT: Zero-Shot
Learning Exercise

Prompt Inquiry
Response

```
python Copy code

import math
import matplotlib.pyplot as plt
import csv

# Set up the parameters
V0 = 1.0 # Output voltage when there is no humidity present
C = 10e-12 # Capacitance of the humidity-sensitive dielectric material
R = 100 # Resistance of the humidity sensor
K = 0.1 # Sensitivity factor of the humidity sensor

# Set up the humidity range to plot
humidity_range = range(0, 100, 5) # Humidity levels from 0% to 95% in steps of 5%

# Calculate the output voltage for each humidity level in the range
output_voltage = []
for H in humidity_range:
    dVdH = 1/C * math.sqrt((K*H)**2 + 1) # Derivative of output voltage with respect to humidity
    V = V0 + R * K * H * dVdH # Output voltage of the humidity sensor
    output_voltage.append(V)

# Plot the output voltage vs. humidity
plt.plot(humidity_range, output_voltage)
plt.xlabel("Humidity (%)")
plt.ylabel("Output voltage (V)")
plt.title("Output voltage vs. Humidity for a Humidity Sensor")
plt.show()

Regenerate response
```

Modeling a Humidity Sensor Using ChatGPT. . .



Google
Colaboratory

```
Humidity_Sensor_w_csv_file.ipynb ☆
File Edit View Insert Runtime Tools Help All changes saved

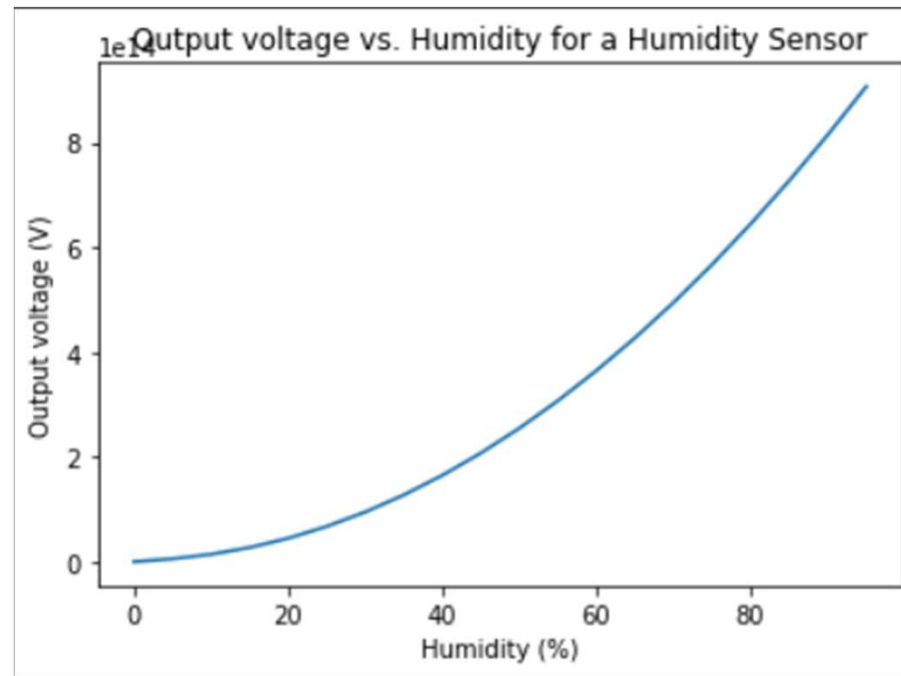
+ Code + Text

1 import math
2 import matplotlib.pyplot as plt
3 import csv
4
5 # Set up the parameters
6 V0 = 1.0 # Output voltage when there is no humidity present
7 C = 10e-12 # Capacitance of the humidity-sensitive dielectric material
8 R = 100 # Resistance of the humidity sensor
9 K = 0.1 # Sensitivity factor of the humidity sensor
10
11 # Set up the humidity range to plot
12 humidity_range = range(0, 100, 5) # Humidity levels from 0% to 95% in steps of 5%
13
14 # Calculate the output voltage for each humidity level in the range
15 output_voltage = []
16 for H in humidity_range:
17     dVdH = 1/C * math.sqrt((K*H)**2 + 1) # Derivative of output voltage with respect to humidity
18     V = V0 + R * K * H * dVdH # Output voltage of the humidity sensor
19     output_voltage.append(V)
20
21 # Plot the output voltage vs. humidity
22 plt.plot(humidity_range, output_voltage)
23 plt.xlabel("Humidity (%)")
24 plt.ylabel("Output voltage (V)")
25 plt.title("Output voltage vs. Humidity for a Humidity Sensor")
26 plt.show()
```

Modeling a Humidity Sensor Using ChatGPT. . .

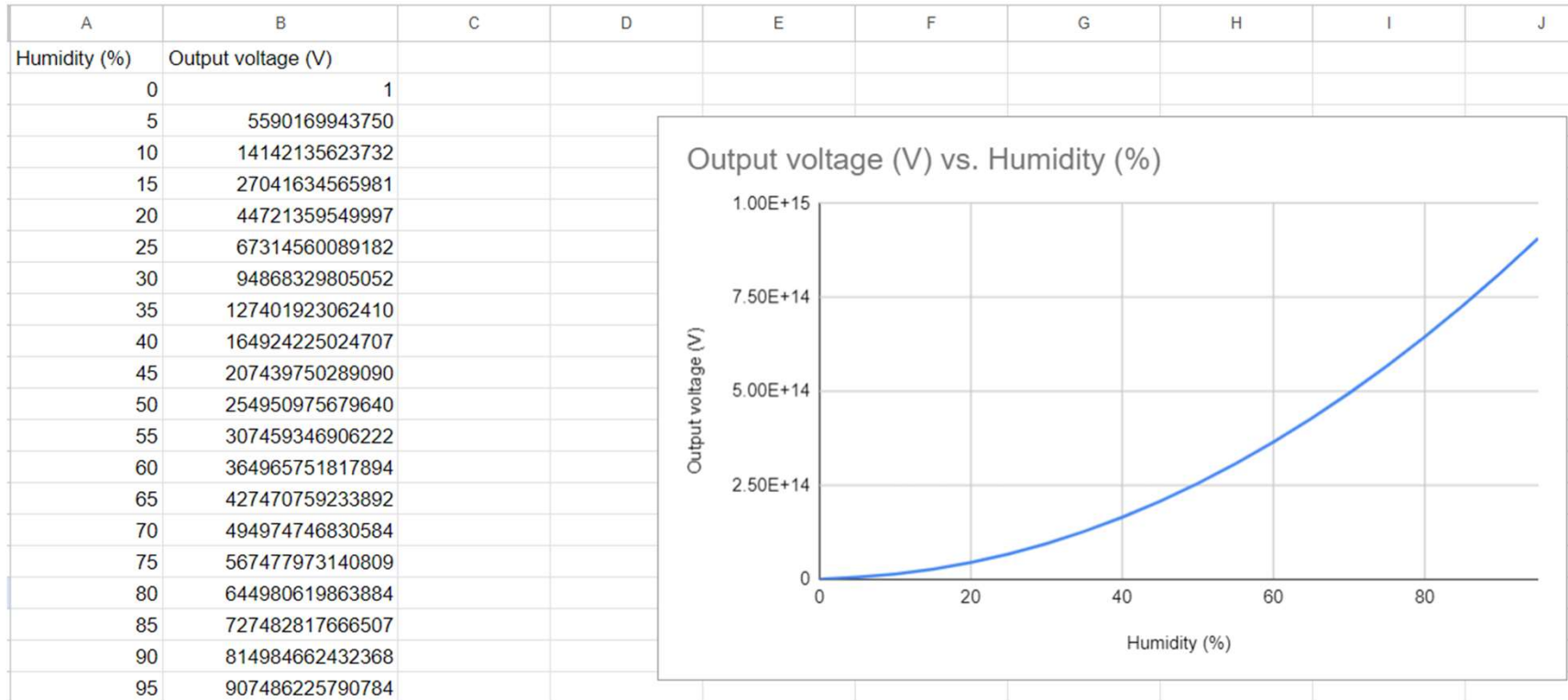


Google
Colaboratory
Plotted Results



Google Sheets Plotted Results

Modeling a Humidity Sensor Using ChatGPT. . .



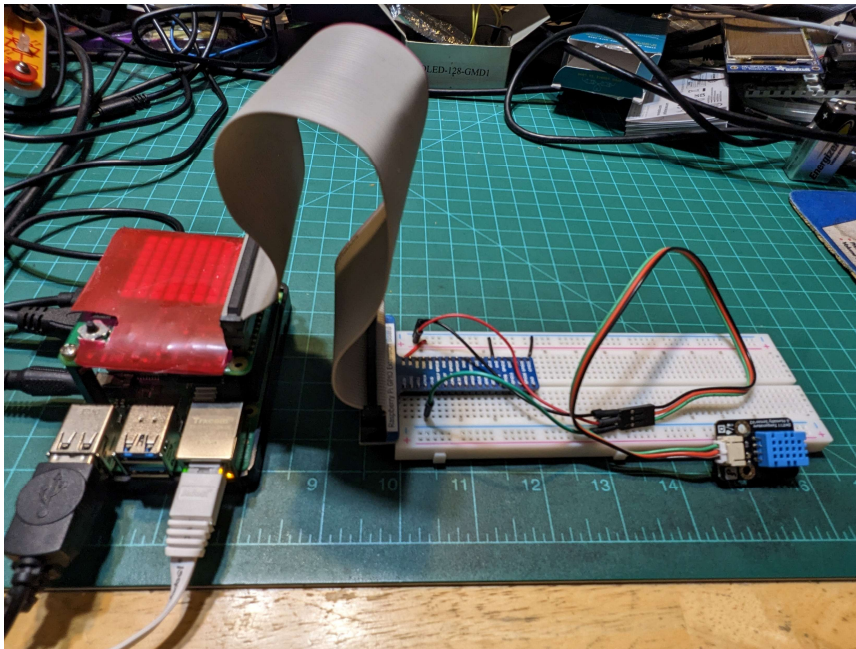
Question 3

The plotted results on slide 20 was created using _____ learning exercise.

- a) Short-Zero
- b) Long Shot
- c) Prompt-Inquiry
- d) Zero-Shot



Lab: Node-RED Temperature-Humidity Sensing Monitor



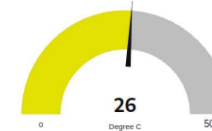
Environmental Sensors

Temperature and Humidity

Humidity



Temperature



Lab: Node-RED Temperature-Humidity Sensing Monitor. . .



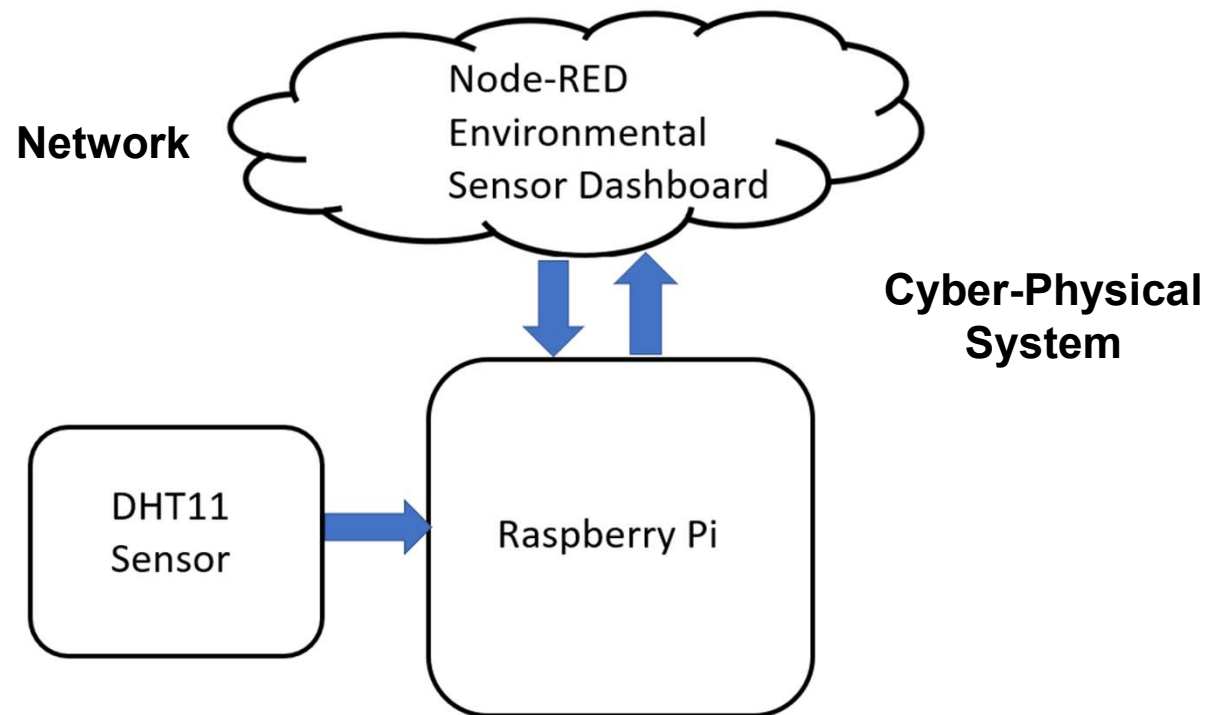
Learning Objectives:

- You will learn to wire a DHT11 sensor to Raspberry Pi using a solderless breadboard.
- You will learn to build a flow diagram using Node-RED Widget nodes.
- You will learn to build an Environmental Sensor Dashboard using Node-RED Widgets.

Lab: Node-RED Temperature-Humidity Sensing Monitor. . .



A Conceptual Temperature-Humidity Sensing/Monitoring System Block Diagram



Question 4

The system block diagram on slide 25 is an example of Physical Computing.

- a) False**
- b) True**



Node-RED: Environmental Dashboard



Functional DHT11 Sensor Monitor Dashboard

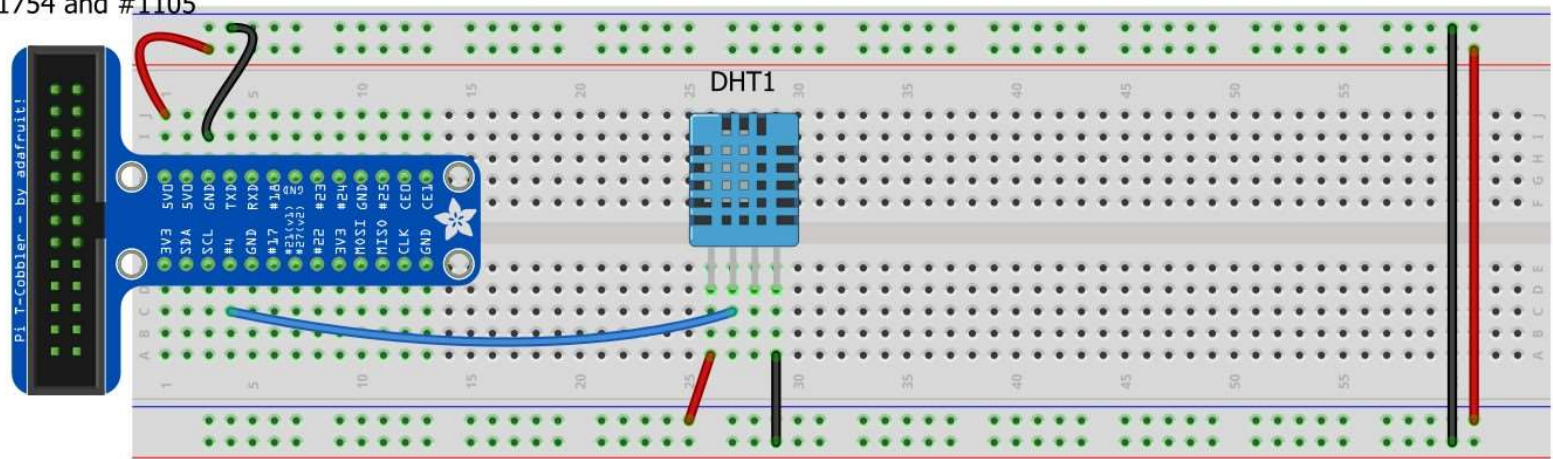


Source:

Lab: Node-RED Temperature-Humidity Sensing Monitor . .



Part1
Adafruit #1754 and #1105

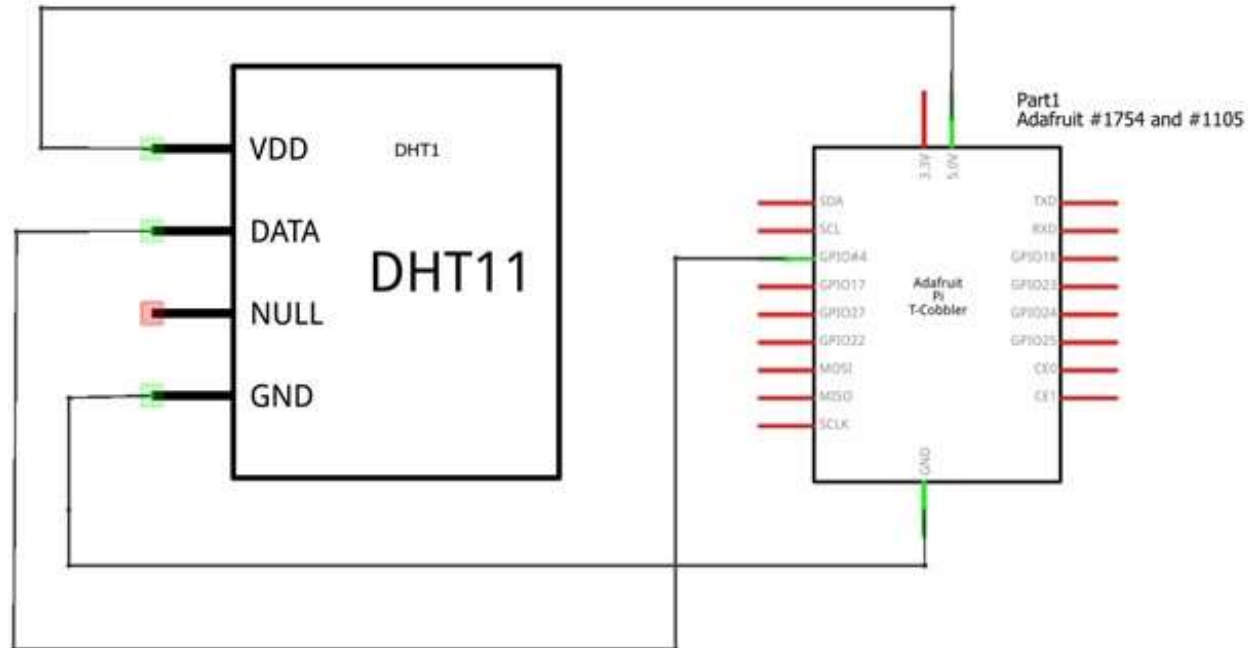


Conceptual
Electrical Wiring
Diagram:
Blue Wire>GPIO4

Lab: Node-RED Temperature-Humidity Sensing Monitor . .



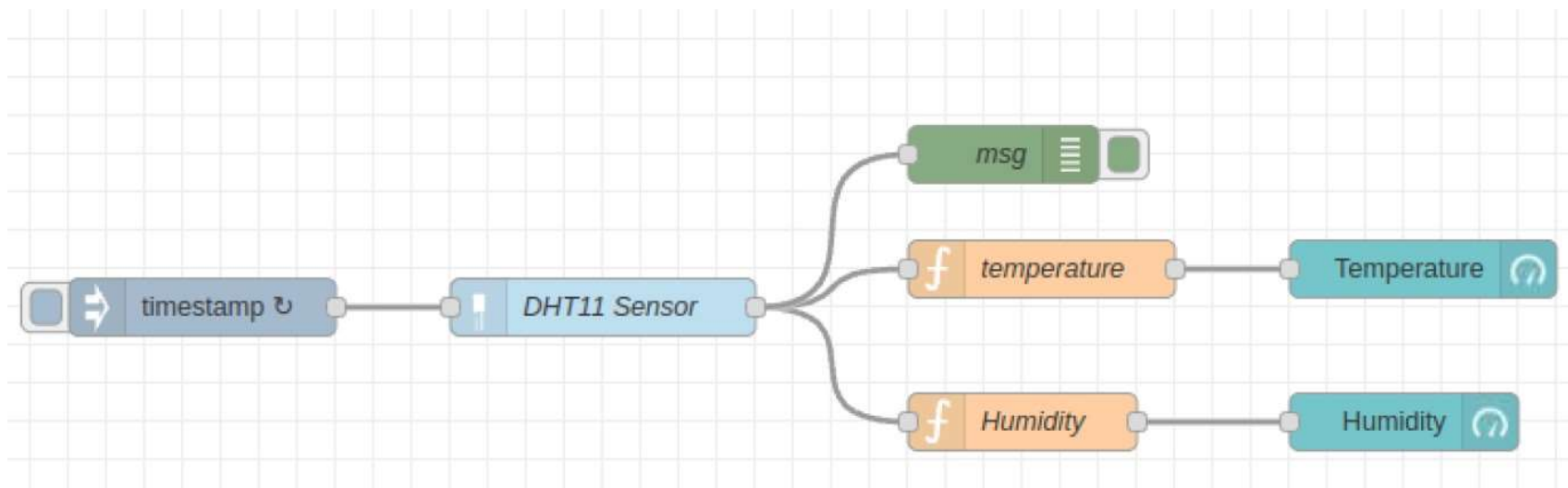
Electronic Circuit Schematic Diagram



Lab: Node-RED Temperature-Humidity Sensing Monitor . .



Flow Diagram



Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Configuring Widget Node Properties



Edit inject node

Delete Cancel Done

Properties

Name Name

msg. payload = timestamp

msg. topic = /

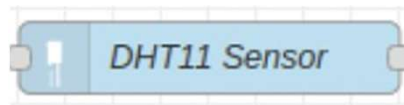
+ add Inject now

Inject once after 0.1 seconds, then

Repeat interval

every 3 seconds

Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Configuring Widget Node Properties



Edit rpi-dht22 node

Delete Cancel Done

⚙ Properties

☰ Topic rpi-dht22

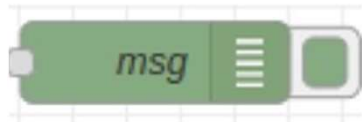
☰ Sensor model DHT11

☰ Pin numbering BCM GPIO

☰ Pin number 4

Name DHT11 Sensor

Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Configuring Widget Node Properties



Edit debug node

Delete Cancel Done

⚙ Properties

☰ Output

🔗 To debug window
 system console
 node status (32 characters)

🏷 Name

Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Configuring Widget Node Properties



Edit function node

Delete Cancel Done

⚙️ Properties

Name temperature

⚙️ Setup On Start On Message On Stop

```
1 return msg;
```

Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Configuring Widget Node Properties



Edit function node

Delete Cancel Done

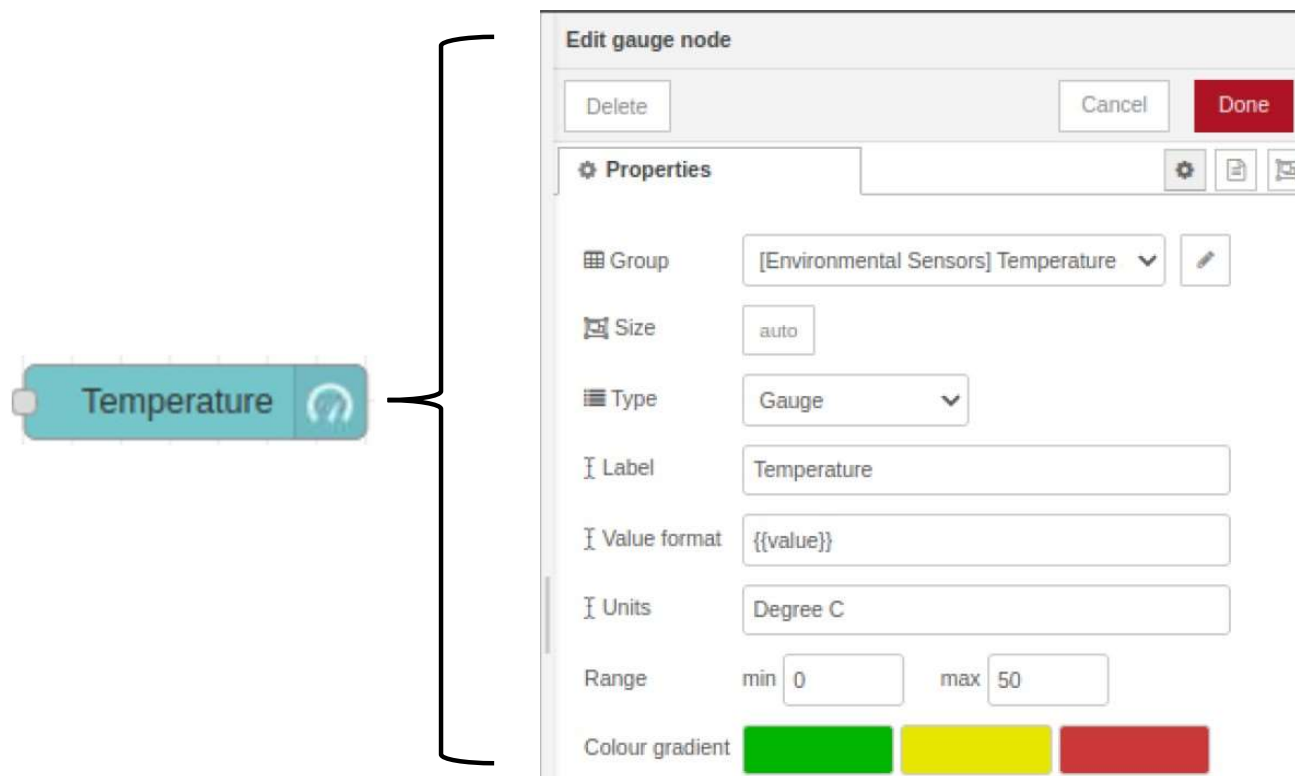
⚙ Properties

📁 Name Humidity

⚙ Setup On Start On Message On Stop

```
1 msg.payload = msg.humidity
2 return msg;
```

Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Configuring Widget Node Properties



Edit gauge node

Delete Cancel Done

Properties

Group [Environmental Sensors] Temperature

Size auto


Type Gauge

Label Temperature

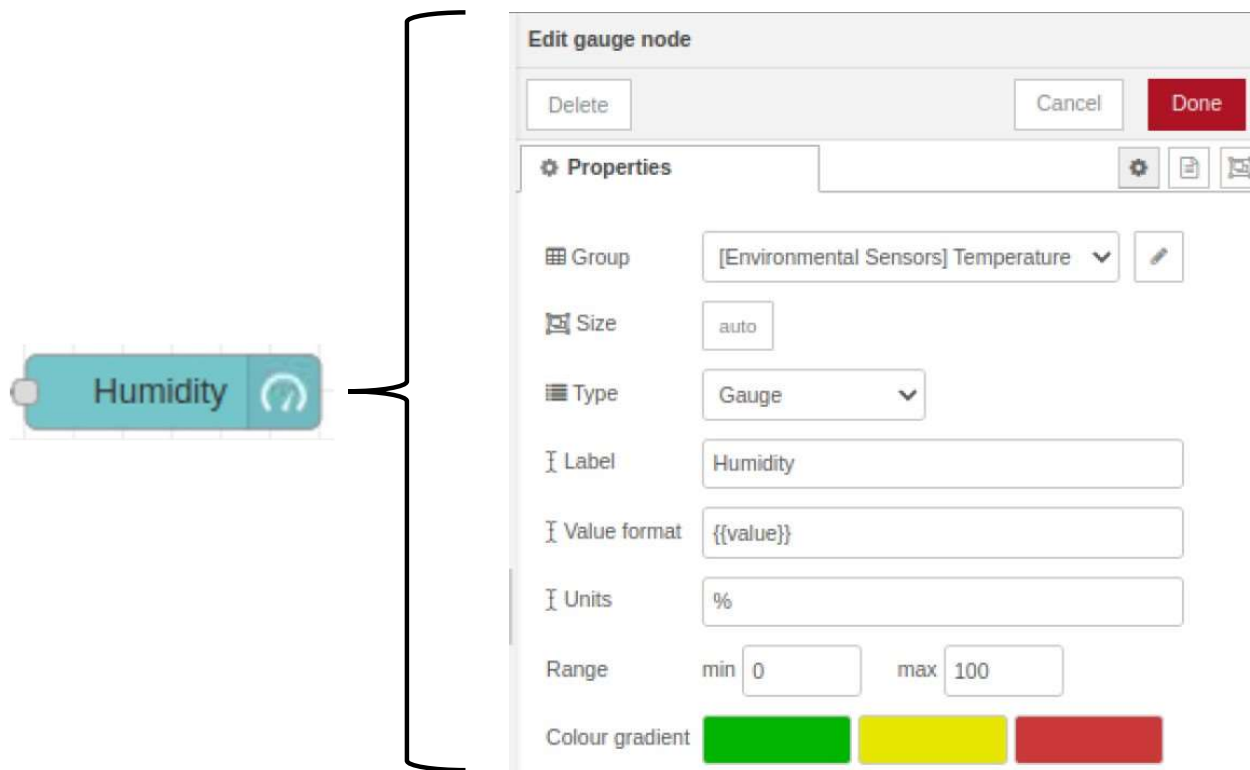
Value format {{value}}

Units Degree C

Range min 0 max 50

Colour gradient 

Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Configuring Widget Node Properties



Edit gauge node

Delete Cancel Done

Properties

Group: [Environmental Sensors] Temperature

Size: auto

Type: Gauge

Label: Humidity

Value format: {{value}}

Units: %

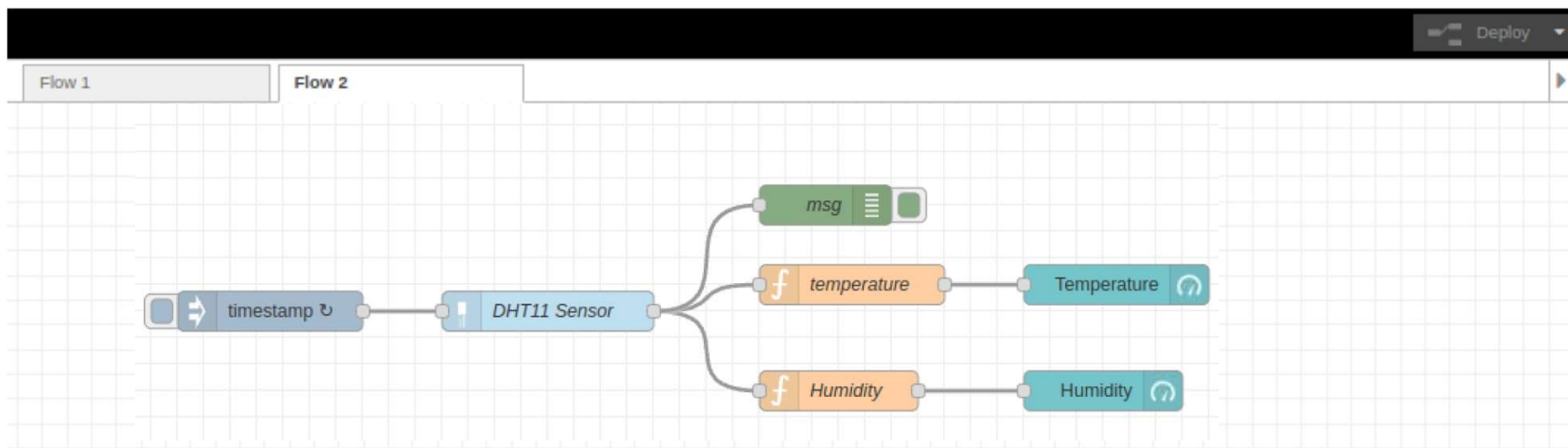
Range: min 0 max 100

Colour gradient: [Green] [Yellow] [Red]

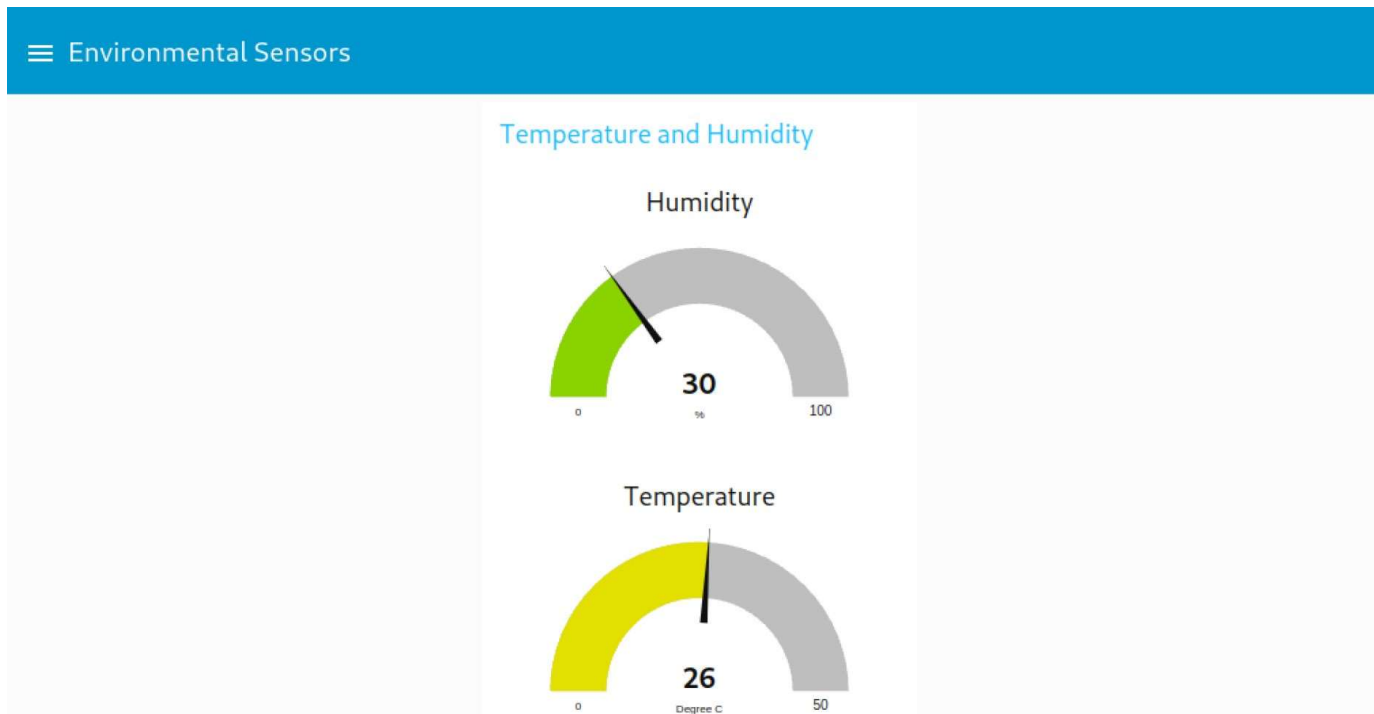
Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Publish Dashboard = Deployment



Click Here to
Publish the
Dashboard



Lab: Node-RED Temperature-Humidity Sensing Monitor . . . Publish Dashboard = Deployment



Question 5

On slide 37, identify the Group Name for the temperature sensor.

- a) Temperature**
- b) Home**
- c) Environmental Sensing**
- d) none of the above**



Thank you for attending

Please consider the resources below:

555 timer application: <https://www.engineersgarage.com/servo-motor-control-using-555-timer-ic/>

ElectronicsTutorial. (2021). Light sensors. [https://www.electronicstutorials.ws/io/io_4.html#:~:text=The%20light%20sensor%20is%20a,%20into%20electricity%20\(electrons\)](https://www.electronicstutorials.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., & Harrisch, 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.

Thank you for attending

Please consider the resources below:

Yang, S. (2011). *Internet-based control systems: Designs and applications*. Springer.

Skraba, A., Stanovov, V., & Semenkin, E. (2019). Modelling of dc motor and educational application in cyber-physical systems. *Materials Science and Engineering*, 537. <https://doi:10.1088/1757-899X/537/4/042008>

Skraba, A., Stanovov, V., & Semenkin, E. (2020). Development of control systems for study of PID controller in the framework of cyber-physical systems. *Materials Science and Engineering*, 537. <https://doi:10.1088/1757-899X/537/4/042008>

Wilcher, D. (2012). *Learn electronics with arduino*. Apress.



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