Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Arr: \_\_\_\_\_\_\_\_\_

Messing Around with Sensors and Switches Worksheet

**Record the digital output values and other observations of all the sensors mentioned and covered in Volume Two.**

You may want to review the following sections in the textbooks:

* Voltage divider board (VDB) theory & analytics (*Chapter 21* on pp 808 – 812)
* Pull-up resistor and VDB theory (*Chapter 21* on pp 819 – 821)

**Sensors *Covered* in the Textbook**

* **2-axis Joystick** (*Chapter 21* on page 798; *Chapter 22* Challenge Problem with button on page 878)

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

x: \_\_\_\_\_\_\_

y: \_\_\_\_\_\_\_

Button not depressed: \_\_\_\_\_\_\_

Button depressed: \_\_\_\_\_\_\_

* **8-Button Board using Pull-up Resistors** (*Chapter 22* on pp 859 – 862)

**Using Internal Pull-up Resistors**

Button(s) not depressed: \_\_\_\_\_\_\_ Button(s) depressed: \_\_\_\_\_\_\_

* **Battery Level Meter (VDB/Fixed Resistor or Commercial Plug-in Meter)** (*Chapter 21* on pp 813 – 814)

**Robot Battery Pack Voltage**

Current: \_\_\_\_\_\_\_ V Post Charging: \_\_\_\_\_\_\_ V

* **Hygrometer** (*Chapter 21* on pp 787 – 793)

**Soil Conditions**

Dry: \_\_\_\_\_\_\_ Damp: \_\_\_\_\_\_\_ Wet: \_\_\_\_\_\_\_

* **IR (Flame) Detector (passive IR)** (*Chapter 21* on pp 794-795)

**Readings of Various IR Sources at Various Distances and Look-Angles**

**Candle (Distance)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

**Incandescent Bulb (Distance)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

**Sun (Look-Angle)**

Direct: \_\_\_\_\_\_\_ (0°)

Close: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ °)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ °)

* **IR Line Sensor (active IR)** (*Chapter 21* on pp 787 – 794)

**Line Colors (Left Sensor)**

White: \_\_\_\_\_\_\_

Light Gray: \_\_\_\_\_\_\_

Dark Gray: \_\_\_\_\_\_\_

Black: \_\_\_\_\_\_\_

**Line Colors (Right Sensor)**

White: \_\_\_\_\_\_\_

Light Gray: \_\_\_\_\_\_\_

Dark Gray: \_\_\_\_\_\_\_

Black: \_\_\_\_\_\_\_

* **Magnetic Field (Hall-Effect) Sensor** (*Chapter 21* on pp 799 – 803; and curve fitting on pp 807 – 808)

No Magnetic Field Present: \_\_\_\_\_\_\_

**Hall-Effect Readings of a Weak Magnetic Field at Various Distances and Incidence Angles**

**North Pole (Distance)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

**South Pole (Distance)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

**North Pole (Incidence Angle)**

Perpendicular: \_\_\_\_\_\_\_ (90°)

Angled: \_\_\_\_\_\_\_ (45 °)

Parallel: \_\_\_\_\_\_\_ (0 °)

**South Pole (Incidence Angle)**

Perpendicular: \_\_\_\_\_\_\_ (90°)

Angled: \_\_\_\_\_\_\_ (45 °)

Parallel: \_\_\_\_\_\_\_ (0 °)

**Hall-Effect Readings of a Strong Magnetic Field at Various Distances and Incidence Angles**

**North Pole (Distance)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

**South Pole (Distance)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

**North Pole (Incidence Angle)**

Perpendicular: \_\_\_\_\_\_\_ (90°)

Angled: \_\_\_\_\_\_\_ (45 °)

Parallel: \_\_\_\_\_\_\_ (0 °)

**South Pole (Incidence Angle)**

Perpendicular: \_\_\_\_\_\_\_ (90°)

Angled: \_\_\_\_\_\_\_ (45 °)

Parallel: \_\_\_\_\_\_\_ (0 °)

* **Pushbutton (NO)** (*Chapter 22* on pp 854 – 857; and using pull-up resistor on pp 858 – 859)

**Using Internal Pull-up Resistor**

Button not depressed: \_\_\_\_\_\_\_

Button depressed: \_\_\_\_\_\_\_

**Using External Resistor or VDB**

Button not depressed: \_\_\_\_\_\_\_

Button depressed: \_\_\_\_\_\_\_

* **Sharp IR Ranger** (*Chapter 20* on pp 749 – 758; and curve fitting on pp 771 – 774)

**Readings of a Large, Flat, Opaque Object**

**at Various Distances and Look-Angles**

**Distance (Range: 6-80cm)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Infinite: \_\_\_\_\_\_\_ ( cm)

**Look-Angle**

0°: \_\_\_\_\_\_\_ (Direct)

15°: \_\_\_\_\_\_\_ (Small Angle)

45°: \_\_\_\_\_\_\_ (Mid Angle)

60°: \_\_\_\_\_\_\_ (Large Angle)

**Readings of a ­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Object**

**at Various Distances and Look-Angles**

**Distance (Range: 6-80cm)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Infinite: \_\_\_\_\_\_\_ ( cm)

**Look-Angle**

0°: \_\_\_\_\_\_\_ (Direct)

15°: \_\_\_\_\_\_\_ (Small Angle)

45°: \_\_\_\_\_\_\_ (Mid Angle)

60°: \_\_\_\_\_\_\_ (Large Angle)

* **SR04 Ultrasonic Ranger** (*Chapter 22* on pp 835 – 845)

**Readings of a ­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Object**

**at Various Distances and Look-Angles**

**Distance (Range: 2-400cm)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Infinite: \_\_\_\_\_\_\_ ( cm)

**Look-Angle**

0°: \_\_\_\_\_\_\_ (Direct)

15°: \_\_\_\_\_\_\_ (Small Angle)

45°: \_\_\_\_\_\_\_ (Mid Angle)

60°: \_\_\_\_\_\_\_ (Large Angle)

**Readings of a Large, Flat, Opaque Object**

**at Various Distances and Look-Angles**

**Distance (Range: 2-400cm)**

Near: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Mid: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Far: \_\_\_\_\_\_\_ ( \_\_\_\_\_\_\_ cm)

Infinite: \_\_\_\_\_\_\_ ( cm)

**Look-Angle**

0°: \_\_\_\_\_\_\_ (Direct)

15°: \_\_\_\_\_\_\_ (Small Angle)

45°: \_\_\_\_\_\_\_ (Mid Angle)

60°: \_\_\_\_\_\_\_ (Large Angle)

* **Switch (SPST)** (*Chapter 22* on pp 863 – 864)

**Using Internal Pull-up Resistor**

Switch open: \_\_\_\_\_\_\_

Switch closed: \_\_\_\_\_\_\_

**Using External Resistor or VDB**

Switch open: \_\_\_\_\_\_\_

Switch closed: \_\_\_\_\_\_\_

*You may need to check state of the switch (open or closed) with a DMM on the continuity or resistance setting.*

* **VDB/Flexion** (*Chapter 21* on page 797)

No bend: \_\_\_\_\_\_\_

**Bend Down**

“Small” bend: \_\_\_\_\_\_\_

“Medium” bend: \_\_\_\_\_\_\_

“Big” bend: \_\_\_\_\_\_\_

**Bend Up**

“Small” bend: \_\_\_\_\_\_\_

“Medium” bend: \_\_\_\_\_\_\_

“Big” bend: \_\_\_\_\_\_\_

* **VDB/Force** (*Chapter 21* on page 797)

“Small” force: \_\_\_\_\_\_\_ “Medium” force: \_\_\_\_\_\_\_ “Big” force: \_\_\_\_\_\_\_

* **VDB/Photoresistor** (*Chapter 21* on pp 787 – 793; curve fitting on pp 804 – 805; and with pull-up resistor on pp 819 – 821)

Bright light: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (lux)

Ambient light: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (lux)

Dim light: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (lux)

No light: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (lux)

* **VDB/Potentiometer** ( *Chapter 21* on page 797)

Full counterclockwise: \_\_\_\_\_\_\_ ¼ turn: \_\_\_\_\_\_\_ ½ turn: \_\_\_\_\_\_\_ ¾ turn: \_\_\_\_\_\_\_ Full clockwise: \_\_\_\_\_\_\_

* **VDB/Thermistor** (*Chapter 21* on page 796; and curve fitting on pp 815 – 818)

Cold temperature: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (K) \_\_\_\_\_\_\_ (° C) \_\_\_\_\_\_\_ (° F)

Cool temperature: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (K) \_\_\_\_\_\_\_ (° C) \_\_\_\_\_\_\_ (° F)

Ambient temperature: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (K) \_\_\_\_\_\_\_ (° C) \_\_\_\_\_\_\_ (° F)

Warm temperature: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (K) \_\_\_\_\_\_\_ (° C) \_\_\_\_\_\_\_ (° F)

High temperature: \_\_\_\_\_\_\_ (raw) \_\_\_\_\_\_\_ (K) \_\_\_\_\_\_\_ (° C) \_\_\_\_\_\_\_ (° F)

* **Whisker (Bumper) Switch Using Internal Pull-up Resistor** (*Chapter 22* on pp 866 – 868)

**Left & Right Whisker**

Switch open: \_\_\_\_\_\_\_ Switch closed: \_\_\_\_\_\_\_

**Some Other Sensors *Mentioned* in the Textbook**

* Color (*Chapter 21* on page 787)
* Humidity (*Chapter 21* on page 787)
* Microphone (*Chapter 21* on page 787)

**Some of the Sensors NOT *Mentioned* in the Textbook**

* Battery-Level Meter/Voltmeter
* Carbon Monoxide (CO)
* Compass
* Conductivity
* Electric Current
* Frequency of Sound
* GPS
* IR Remote Board
* Tilt Switch (Mercury Switch)
* Turbidity
* Vision (Pixicam)