4.1 Worksheet: Introduction to Digital Sensors

Name: ______________________ **Class/Period:** ____________ **Date:** ______

Answer the following questions:

1 In your own words, what is a sensor?

____

____

____

____

2 List 4 types of sensors, explain their purpose and provide a real world example.

1:	Type:
	Purpose:
	Example:
2:	Type:
	Purpose:
	Example:
3:	Type:
	Purpose:
	Example:
4:	Type:
	Purpose:
	Example:

3 Why do robots need sensors?

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4.2 Activity: Open-Loop vs. Closed-Loop Navigation

Name: ____________________ **Class/Period:** ___________ **Date:** ______

Question Sheet

Question 1 How did your path compare to the original maze? Did the path drawn follow the maze to the end? Why or why not?

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Question 2 How did your partner's path compare to the original maze? Did the path drawn follow the maze to the end? Why or why not?

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Question 3 If the paths drawn did not follow the mazes properly, is there a better way to traverse the maze? Provide details.

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Question 4 Did the path drawn by the driver correctly solve the maze? Identify any issues or problems with this method of solving the maze.

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Question 5 Compare the results of the open-loop solution in the previous section (4.2.1) with the closed-loop solution conducted here. Which procedure provided a more accurate solution to the maze? Why?

Question 6 What are the advantages and disadvantages of the open-loop method used in 4.2.1?

Question 7 What are the advantages and disadvantages of the closed-loop method used in 4.2.2?

Question 8 If you need to traverse the maze using a robot, how would you design and program the robot?

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4.3 Worksheet: Open Loop Vs Closed Loop Systems

Name: ____________________ **Class/Period:** ____________ **Date:** ______

Answer the following questions:

1 Looking at the world around you, provide 5 examples of an open loop system and 5 examples of a closed loop system.

	Open Loop	Closed Loop
1		
2		
3		
4		
5		

2 In your own words, define:

Open Loop

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____

____

Closed Loop

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____

____

Feedback

____

____

____

3 When designing a robot, why is feedback so important?

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4 What issues do you have to be concerned about when designing a system with feedback?

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4.4 Worksheet: Introduction to Digital Sensors

Name: ______________________ **Class/Period:** ____________ **Date:** ______

You have learned that digital sensors have only 2 possible states. These states can be called "on" or "off", "1" or "0", or "one state" and "its opposite state". Think about digital sensors when you answer the following questions:

1 Look around, your classroom, your house, while you are traveling to and from school, what examples of digital systems or digital sensors can you find? (list at least 5).

1 ______________________________

2 ______________________________

3 ______________________________

4 ______________________________

5 ______________________________

2 What port or ports on the Vex Controller can you connect to digital sensors such as the Bumper Switch or Limit Switch?

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____

3 Explain the difference between a digital sensor and an analog sensor.

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4 Your friends would like you to develop a doorbell for their room. They would like to have a button outside their room door. When someone wants to visit, they would push the button. Inside the room a light goes on and a buzzer makes a noise for 3 seconds.

Think about this challenge and answer the following questions:

A. What sensor will be used in this application?

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____

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B. Write the Pseudocode that indicates the steps your program will take to solve this problem.

____

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4.5F Activity: Bumper Car - Fundamental

Name: ____________________ **Class/Period:** ____________ **Date:** ______

Question Sheet

Question 1 What did your robot do?

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Question 2 Were there any problems with your robot?

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Question 3 How could you improve your robot to better meet the design criteria?

____

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Question 4 In what application could this type of robot be used?

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4.6 Worksheet: Echolocation and the Speed of Sound

Name: ______________________ **Class/Period:** ____________ **Date:** ______

As we have learned, echolocation is based on measuring the "time of flight" for a sound to leave the sensor, hit the target object and bounce back. The most important variable to consider in this case is the medium through which the sound travels.

In our case, the medium is air and the speed of sound is fairly constant, varying slightly depending on the density of the air (which in turn changes with temperature, pressure and humidity). At room temperature, under normal conditions, the speed of sound is 1132 ft/sec.

Suppose you look outside during a thunderstorm and see a bolt of lightning. Three seconds later, you hear the thunder. Can you tell how far away the lightning storm is from you? *(1 mile is 5280 feet)*

Answer the following questions:

1 If the delay is three seconds, how far away is the storm?

____

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2 How many seconds does it take sound to travel one mile?

____

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Now consider the much shorter distances that the ultrasonic sensor might measure. Remember that in this case, we are considering a round trip time rather than one way. For distances that are very short like those that the sensor measures it is more convenient to think in milliseconds rather than seconds. *(A millisecond is 1/1000 of a second)*

3 What would be the measured time for an object one foot away?

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____

4 How about an object 8 feet away?

____

____

5 How many milliseconds elapse for each inch of travel?

____

____

____

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4.7 Activity: Ultrasonic Rangefinder

Name: ______________________ **Class/Period:** ____________ **Date:** ______

Question Sheet

Question 1 How many units are returned for 4 feet?

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Question 2 How many units are returned for 5 feet?

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Question 3 Are your results any different if you use an obstacle made of a different material?

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Question 4 Are your results any different if a flat surface of the object is not directly facing the sensor?

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continued

Question 5 How close to your goal of 12" does the robot actually stop?

Question 6 What might prevent the robot from stopping when you told it to?

Question 7 How can you make the robot stop close to your target distance?

Question 8 It is relatively easy to adjust your code to make the robot stop at 12 inches. However, the results may be affected by changes in conditions, such as floor surface, a given set of wheels, and wall approach speed. How would you make sure that it stops reliably under changing conditions?

continued

Question 9 What could you do to make the robot stop at any predetermined distance?

Question 10 What advantages does the Ultrasonic Rangefinder robot have over the Bump Switch version?

4.8 Worksheet: Line Tracking Sensors

Name: ______________________ **Class/Period:** ____________ **Date:** ______

1 Identify 2 real-world examples of line following navigation and control systems. Explain how each application uses line following to accomplish their task.

1 ____

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2 ____

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2 If you were designing a robot that would follow a line, what would you want it to do if it was off or away from the line?

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3 What should the robot do if it is on the line?

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4 Explain how a line follower sensor works. What components are included within a line follower?

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continued

5 What issues or concerns do you have to be aware of in a robot's environment when using a line follower?

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6 You want your robot to calibrate its line following sensor upon startup. When your robot is over the black line it reads a value of 442 and when it is over the background it reads a value of 24. Calculate the midpoint value that you will use as a cutoff point in your robot's programming to decide if the sensor is on the line or off the line.

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4.9 Activity: The Line-Following Sensor

Name: ____________________ **Class/Period:** ___________ **Date:** _____

Question Sheet

Question 1 Which surfaces seem to have the greatest influence over your readings?

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Question 2 If you sampled multiple colors, order them numerically. Is the order unique to your line follower, or do you see a familiar pattern?

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Question 3 For the colors and materials you sampled, was color or texture a more important determining factor? Explain.

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Question 4 Were the effects of changing height similar between both the surfaces you measured?

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4.10 Worksheet: Drive Exploration

Name: ______________________ **Class/Period:** ____________ **Date:** ______

1 You send the following values for speed and direction into the function Drive. Identify the PWM values that will eventually be sent to the motors (assuming a 2 wheel drive robot) by the functions in the library.

Speed	Direction	Left Wheel PWM	Right Wheel PWM
0	95		
-60	0		
35	50		
-25	-80		
-75	50		
-80	-90		
70	-65		
100	100		

Note: Assume a large CC value (example 255) will make the left wheel travel forward, and that the drive motors are mounted in opposite directions.

4.11 Activity: Advanced Driving Exercises

Name: ____________________ **Class/Period:** ____________ **Date:** ______

Question Sheet

Question 1 How well did the robot drive in a complete circle? Did it always return to the point of origin after completing one revolution?

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____
____
____
____
____
____
____

Question 2 Describe your approach to programming the robot to drive in a spiral.

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____
____
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____
____
____
____
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4.12F Activity: Line Following - Fundamental

Name: ____________________ **Class/Period:** ___________ **Date:** _____

Question Sheet

Question 1 Do you notice any differences running your robot in one direction versus the other (clockwise vs. counterclockwise)?

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Question 2 If your robot has more difficulties driving in one direction than the other, what could be the cause?

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Question 3 Does your robot have more trouble with particular sections of the track?

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Question 4 Analyze the times you recorded. Are the results as you would have predicted?

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____

continued

Question 5 Does your robot have more trouble line following in one direction than the other? Speculate as to why this is or isn't the case.

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Question 6 How does your current line following algorithm differ from the previous single sensor case? Compare and contrast the two methods, analyzing both ease of programming and results.

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Question 7 Question 7 If you could get additional line-tracking sensors, how would you use them to further improve your robot's performance?

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