9.1 Worksheet: Proportional Control

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

Answer the following questions:

1 What is the equation for proportional control? What is the equation for Error? Identify each of the variables.

2 In the case of the ultrasonic robot heading towards a wall, what does each of these variables represent?

3 Estimate the starting k_p value you will use in the next activity. The robot will have to stay 15 inches from a wall using the ultrasonic sensor. If you are using the Drive Libraries, your possible output values can range from positive to negative 127. Show your work.

9.2F Activity: Using Proportional Control – Fundamental

Name: **Class/Period:** **Date:**

Question Sheet

Question 1 How repeatable is the robot's action?

Question 2 How close to the 15 inches line can your robot get?

Question 3 How did you reach your final k_p value?

Question 4 What is the lowest k_p value that works to keep your robot running? The highest?

Question 5 Which part of the Drive library handles overflow? How does it do this?

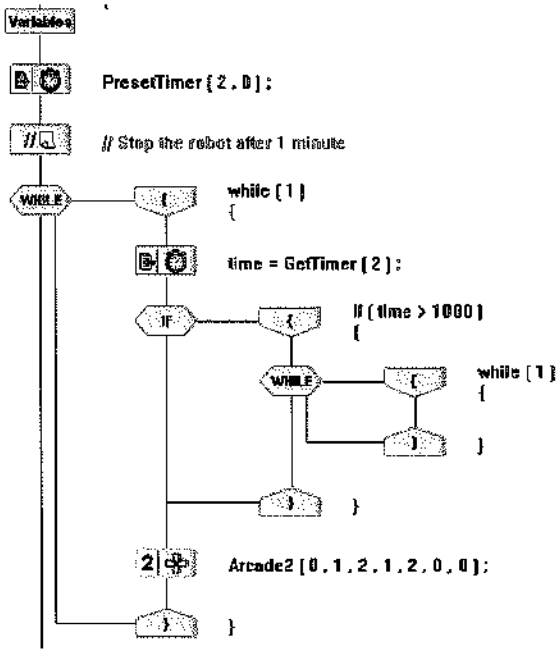
9.3 Worksheet: Derivative Control

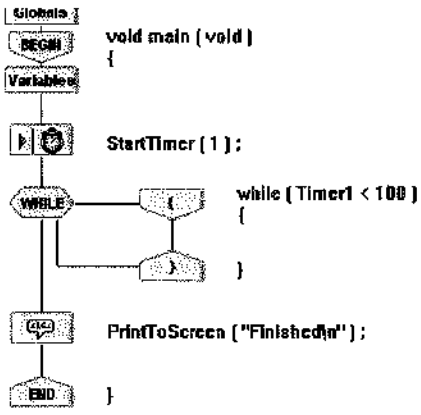
Name: _____ **Class/Period:** _____ **Date:** _____

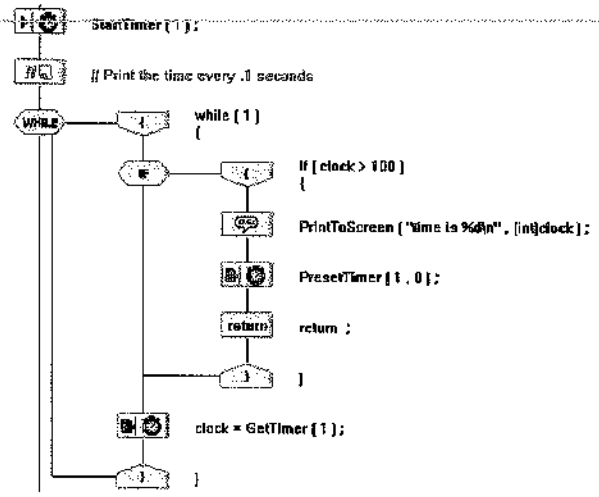
Answer the following questions:

1 What is the equation for PD control? Identify each of the variables.

2 What is wrong with each of the following programs?






StartTimer (1) ;
// Print the time every .1 seconds
while (1)
{
If (clock > 100)
{
PrintToScreen ("time is %d\n" , (int)clock) ;
PresetTimer (1 , 0) ;
return ;
}
clock = GetTimer (1) ;
}

9.4F Activity: Using Derivative Control – Fundamental

Name: **Class/Period:** **Date:**

Question Sheet

Question 1 What is your k_d value? Why did you choose this?

Question 2 What is your k_p value? Why did you choose this and how does this affect the robot?

Question 3 Under what circumstances would a PD algorithm be more beneficial than simply a proportional algorithm? Similarly, when would a PD algorithm be worse than a P algorithm?

9.6 Activity: Integral Control

Name: **Class/Period:** **Date:**

Question Sheet

Question 1 What was your initial value for k_i? Why did you choose this?

Question 2 What were your final values for k_i, k_d and k_p? How did these values change from previous exercises? Why did you make these changes and what impact did they have on the robot's movement?

Question 3 Did you change your code after testing the robot on a ramp? What was changed and why?

Question 4 Under what circumstances would PID control be more beneficial than PD control? What about just proportional control?

9.7 Worksheet: Defining Arrays

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

Answer the following questions:

1 Draw the arrays defined below:

Storage[5]	Bin[1][5]
Memory[3][2]	Deposit[2][4]

2 For the array Memory[3][2], fill in the array incrementally, drawing each step as you go.

Memory[2][1] = 9	Memory[2][0] = 6
Memory[0][1] = 4	Memory[2][1] = 5

3 How would you write an easyC assignment with a value of 7 using only the values stored in the array Memory from the previous question?

_____

4 What syntax would you use to preload the array shown below?

1	3	5
2	4	6

_____

9.8 Activity: Data Filtering and Graceful Degradation

Name: **Class/Period:** **Date:**

Question Sheet

Question 1 Why is an array the best choice in this application?

Question 2 Could this be accomplished without using arrays? If so, how?

Question 3 Give an example of when replaying an action done by a person (as opposed to a pre-programmed sequence) is beneficial.

Question 4 What happens when you unplug the ultrasonic sensor?

Question 5 What would happen if you held your hand (without waving) in front of the robot?

Question 6 Did you use a running average? If not, how did your solution differ?

Question 7 At what values does your program begin to ignore data? Why did you choose this value?

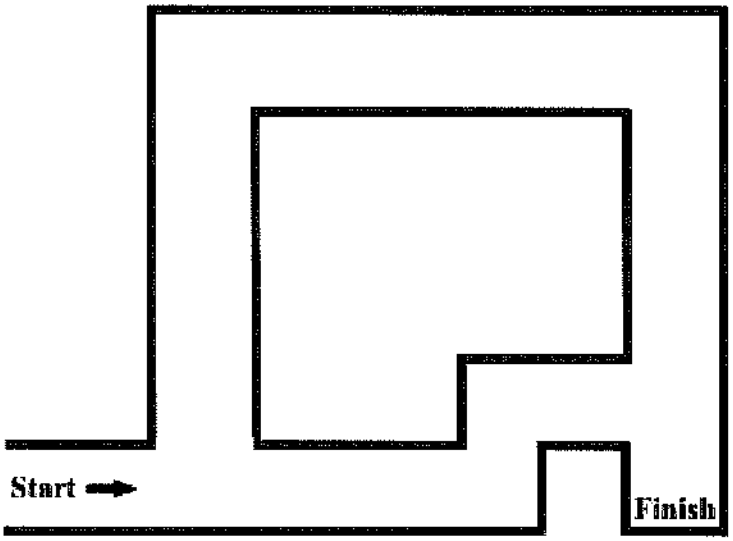
9.9 Worksheet: Behavioral Maze

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

Answer the following questions:

1 Structure the following behaviors so that the robot completes the maze in the shortest amount of time. Indicate which behaviors are dependant (are checked only if an earlier behavior has already triggered), if any. You may not need every behavior.

- Drive straight forward
- If the right sensor sees an open space, turn right
- If the left sensor sees an open space, turn left
- If the front sensor sees a wall, stop
- Drive 12" forward



Assume the following:

- The robot always drives straight and the robot always makes 90° turns in place
- All the corridors are 24" wide and the robot is just under 24" in diameter (it is round)
- The robot has front, right, and left ultrasonic sensors with less than a 1" range

2 Although this was not required for question #1, does your program complete the maze in reverse? Why or why not?

9.10F Activity: Build a Vacuuming Robot - Fundamental

Name: **Class/Period:** **Date:**

Question Sheet

Question 1 Did you have to change the bumper design to fit your robot? If so, what did you change and why? If not, would your robot have benefitted from this?

Question 2 With a centered wheel base, how did you "balance" your robot?

Question 3 Where is the optimal location for the line followers?

Question 4 How did you wire your circuit?

9.12 Activity: Writing a Roombot Behavior

Name: **Class/Period:** **Date:**

Question Sheet

Question 1 What would happen if the robot were told to backup for an extended distance after detecting an edge?

Question 2 Is there any way to eliminate the problem proposed in question 1?

Question 3 Where did the robot have problems on the field? Why was this and what can be done to fix them?

Question 4 If the robot is placed in the same spot in the same orientation twice in a row, will the robot have the same path? If so, what makes this program different from a dead reckoning program?

9.13 Worksheet: Modulus

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

Answer the following questions:

1 Calculated the following:

13 % 4 = _____

6 % 6 = _____

20 % 15 = _____

5 % 1 = _____

2 Describe what the function below will accomplish. Assume that the digital outputs are connected to LEDs on a bread board.

```
void bin ( int v )
{
    int r;

    if ( v!=0 )
    {
        r=v%2 ;
        if ( r==1 )
        {
            SetDigitalOutput ( x , 1 ) ;
        }
        else
        {
            SetDigitalOutput ( x , 0 ) ;
        }
        x++ ;
        v/=2 ;
        bin ( v ) ;
    }
}
```

_____

_____

_____

_____

_____

9.14 Activity: Generating Random Numbers

Name: **Class/Period:** **Date:**

Question Sheet

Question 1 Describe what numbers you think will be printed to the terminal window.

Question 2 Is the value that you have produced random, or would it be random enough for turning? If not, why?

Question 3 Create a hypothesis as to why the numbers you observed were printed as they were.

Question 4 Did the displayed value change? If so, why? If not, why not?