**SLIDE 19**

\*Stirring subsystem leader introduces me to speak about SIMAVR\* \*NEXT SLIDE\*

**SLIDE 20**

Every motor on all 3 subsystems require some sort of output from the Arduino microcontroller, but our input sensors can only pick up raw voltage values which are meaningless to the operators of the bioreactor. So, we needed a way to convert these values into meaningful data that can be understood by people who can then adjust the set points to their desired values.

I’ll then now speak briefly about all 3 subsystems. For the heating subsystem, the thermistor generates an analogue signal, which is given in voltage. The voltage is converted to degrees Celsius by calibration and the Arduino can then generate a PWM output to the heater.

For the stirring subsystem, the lightgate generates a digital signal that is on or off depending on whether the light is transmitted or obscured. Time taken is recorded for a fixed number of revolutions to calculate the rpm of the system, and then a PWM output is sent to the stirrer motor.

Lastly, for the ph subsystem, the input is an analogue value from a pH sensor. This voltage is converted into pH values, again, via calibration, and Arduino controls the PCA9685 board using I2C, which then controls the acid and base pumps. \*NEXT SLIDE\*

**SLIDE 21**

So how did we exactly do calibration and test our system to see if its working? \*NEXT SLIDE\*

**SLIDE 22**

For the bioreactor to correctly react to different set points, our system needs to know to what extent that their values need to change. To do that, we had to calibrate the input values such that they are similar to the values recorded by our thermometer, lightgate, and the ph probe.

We first changed the output of the individual subsystem such as increasing the heating, or adding some acid to the system. We then recorded the values that our sensors picked up and call them the actual value, and the input values of our probes and called them the measured value.

A graph of measured values against actual values is then plotted to calculate the relationship between the 2 values. We made sure that lots of values are recorded so that the calculations are more accurate. \*NEXT SLIDE\*

**SLIDE 23**