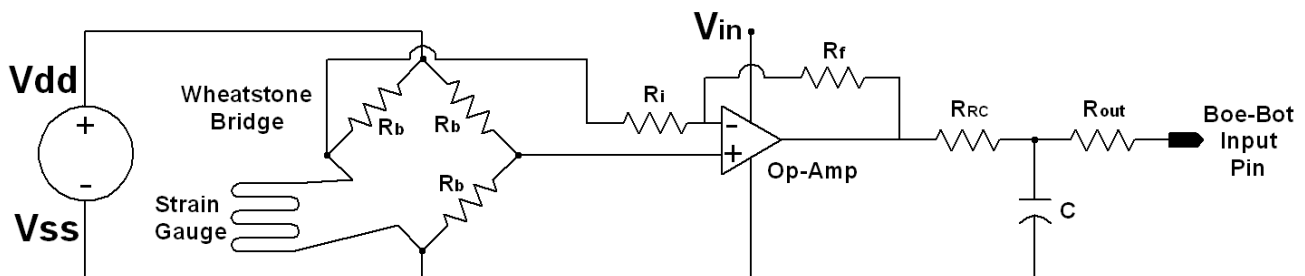


## Force Measurement using Strain Gauges

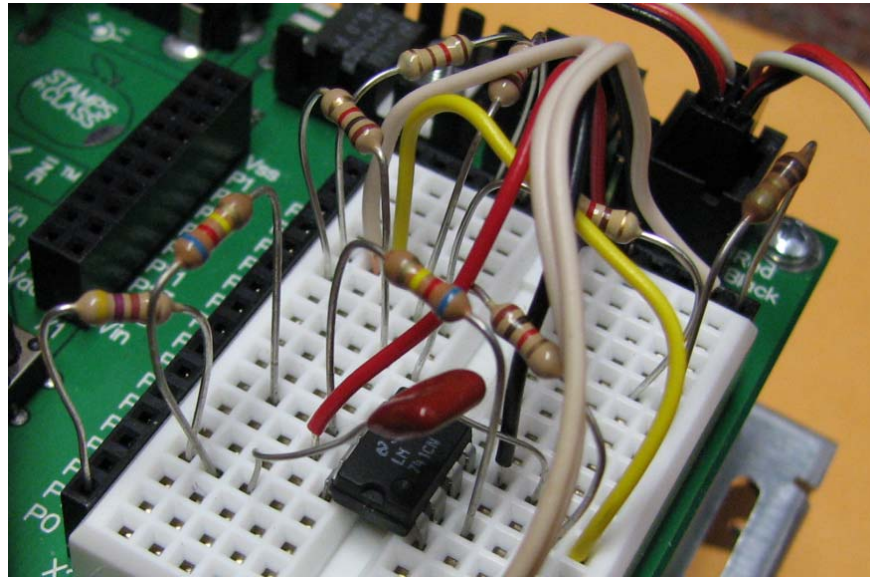
1. Apply the strain gauge to the tensile specimen (both provided in class)  
<http://www.youtube.com/watch?v=a9zBQbnW3g8>
2. Solder wires to the strain gauge (apply tape as strain relief)



3. Build the circuit described in class as shown below.
  - a. Try to “balance” the bridge by carefully selecting the 120Ω resistors. (Resistors that are “120Ω” are not really exactly 120Ω. You will have to measure several of them and select a combination that causes the bridge to have nearly zero voltage across it.)
  - b. The op-amp must accept a negative voltage input through  $R_i$ , you may have to move the strain gauge to the other side of the bridge to accomplish this.
  - c. The gain of the amplifier circuit is given by:  $\text{Gain} = -\frac{R_f}{R_i}$ . The gain may need to be changed to yield an appropriate gain that will not saturate the amplifier and that will yield a signal that the Boe-Bot can measure. Changing the resistance values changes the gain.
  - d. The table shown gives the values for the various components that your instructor found to work.



$R_i$	4.7 kΩ
$R_f$	310 kΩ
$R_{RC}$	620 kΩ
$R_{out}$	470 Ω
$R_b$	120 Ω
C	0.01 μF
Op-Amp	TL3472



4. Use the following code as a starting point to get your Boe-Bot to read the voltage coming from the op-amp. This voltage should be proportional to the amount of strain that the strain gauge is experiencing, which is in turn proportional to the force being applied to the member.

```

' {$STAMP BS2}
' {$PBASIC 2.5}

' This program determines the time for an RC circuit to charge from zero volts up to 1.4
' volts (the transition from LOW to HIGH for the BASIC Stamp 2). The idea is to associate
' the output of the RCTIME command with the resistance change of the strain gage. Since
' strain is proportional to stress and force, the ultimate goal is to find a relationship
' between the RCTIME output, given by the variable rct, and the applied force.

rct VAR Word                                ' define variable to store the output of the RCTIME command

DO
  LOW 0                                       ' discharge the capacitor, sending voltage back to zero
  PAUSE 500                                  ' sets a 500 ms loop time
  RCTIME 0,0,rct                             ' rct stores the number of 2us time intervals it takes
                                           ' for the RC circuit (defined by RRC and C) to charge
                                           ' from zero volts to 1.4 volts
  DEBUG "RCTIME = ", DEC rct,CR             ' displays raw RCTIME output
LOOP

```

5. Perform an experiment where you determine the relationship between the force applied to your specimen and the voltage reading seen by the Boe-Bot. To do this you will need to incrementally increase the amount of load applied to the specimen and track the readings indicated on your debug screen. By plotting loads versus voltage (or raw RCTime values, if you prefer), you should be able to make a calibration relationship that you can enter into your PBASIC program and read out force directly on your computer screen.