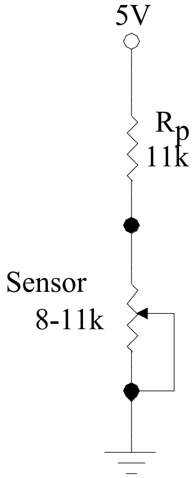
ME218a Final 1996 Problem #1

The simplest solution is to put the sensor into a voltage divider circuit

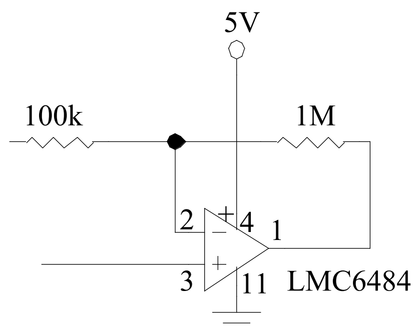


If we make Rp=11k, we will get maximum voltage at 10% RH = 2.5V

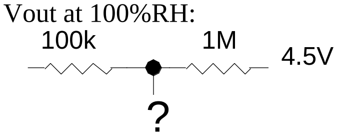
At 100% RH $V = 5\left(\frac{8}{19}\right) = 2.1V$

ΔV = 0.4V

We want that ΔV to cover the 0.5V-4.5V output range. ΔVo=4V, ΔVi=0.4V there fore the gain should be 10. TO get the minimum output volatage at the minimum RH, use an inverting OpAmp:



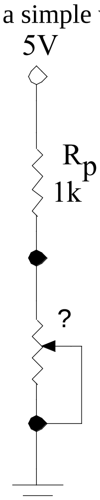
To compute the required offset, look at Vin and Vout at 100%RH:



$$i = \frac{4.5 - 2.1}{1.1M\Omega} = 2.1818\mu A$$

$$? = 4.5V - 2.1818\mu A * 1M\Omega = 2.318V$$

This can be obtained with a simple voltage divider:



$$5\left(\frac{?}{?+1k}\right) = 2.318V$$

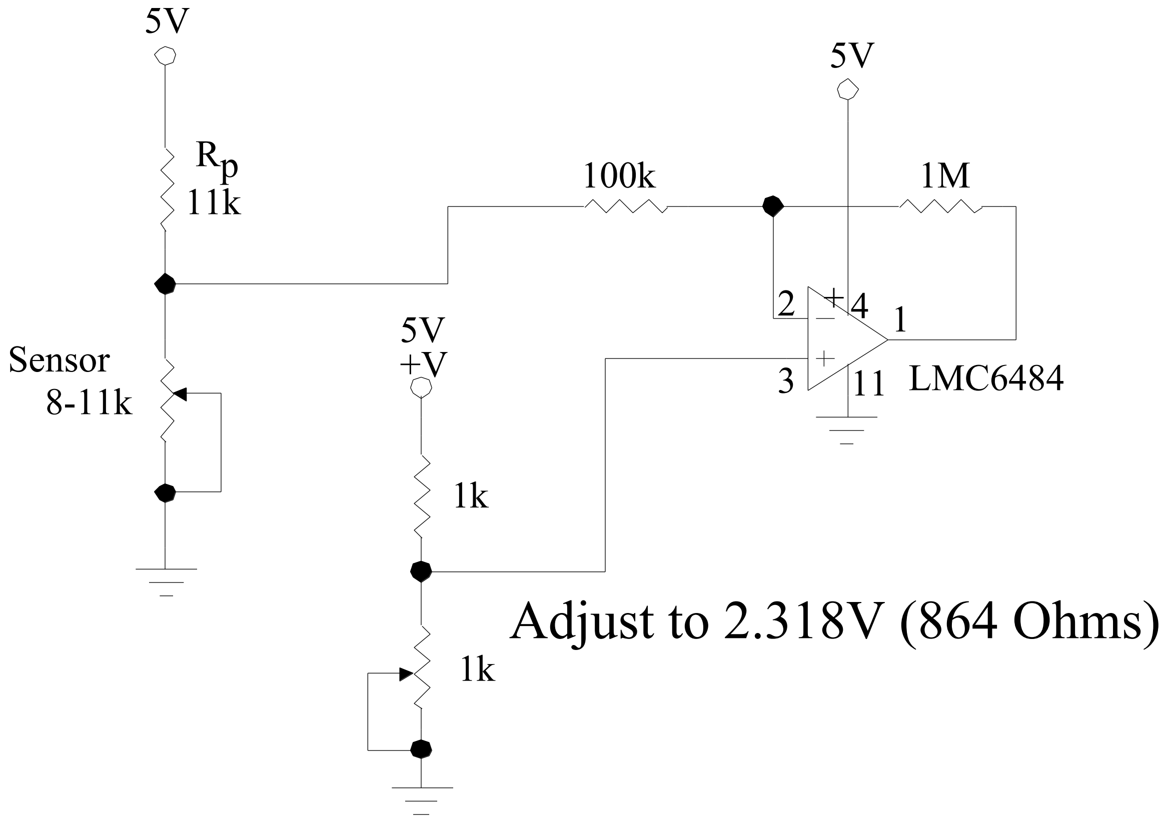
$$\frac{5?}{?+1k\Omega} = 2.318V$$

$$5? = 2.318? + 2.318k\Omega$$

$$2.682? = 2.318k\Omega$$

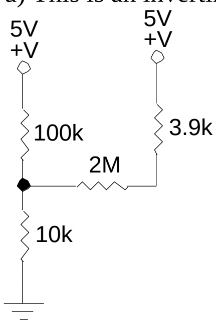
$$? = 864\Omega$$

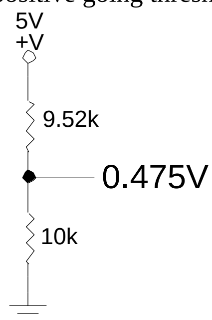
The complete solution:



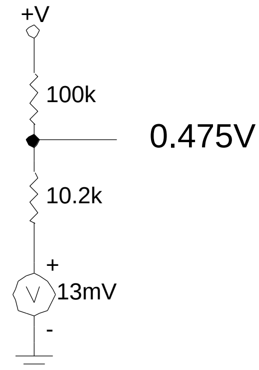
ME218a Final 1996 Problem #2

a) This is an inverting comparator, so the positive going threshold will be when V_O=Hi.





$$\frac{10}{105.2}\,5V = 0.475V$$

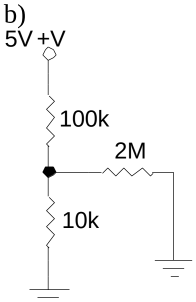


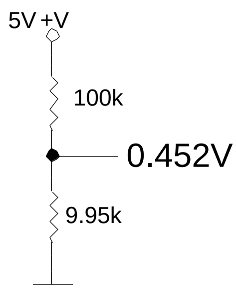
$$i = \frac{5-0.475}{100k} = 4.525e^{-5}$$

$$10.2ki = 0.462V$$

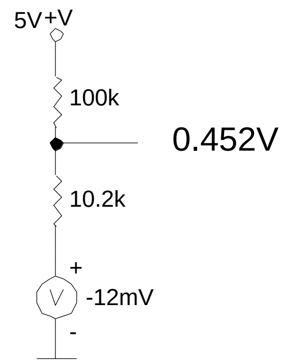
$$V_{th} = 0.475 = 0.462 = 13mV$$

b)





$$\frac{9.95}{109.95}\,5V = 0.452V$$

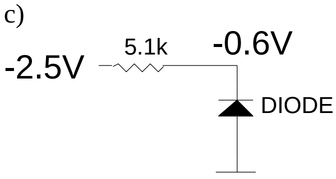


$$i = \frac{5-0.452}{100k} = 4.548e^{-5}$$

$$10.2ki = 0.464V$$

$$V_{th} = 0.452 = 0.464 = -12mV$$

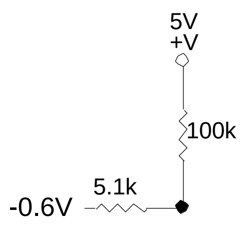
c)



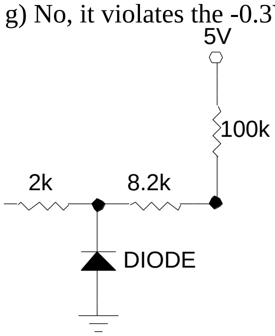
$$\frac{2.5-0.6}{5.1k} = 0.37mA$$

d) V_{in} is always less than +5V, so it will never source any current.

e) The maximum common mode voltage is at the positive threshold: 0.475V

f) The minimum voltage seen by the 339 is  = -0.328V

g) No, it violates the -0.3V spec. to fix it, change the 2 5.1k resistors to a 2k + 8.2k:

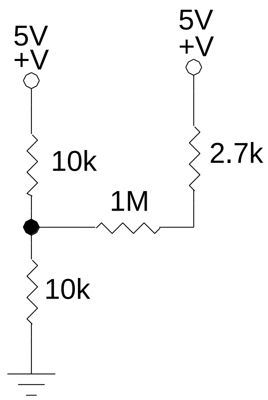


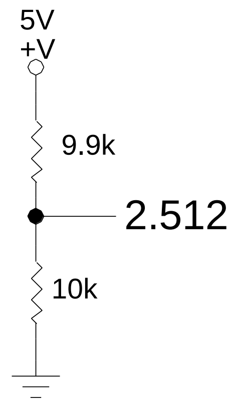
New minimum = -0.175V, nothing else will be effected because the total still = 10.2k

h) $\frac{5}{3.9k} + \frac{0.452}{2M} = 1.28mA$ Dominated by the 3.9k

ME218a Final 1996 Problem #3

a)



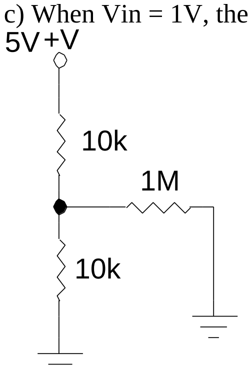


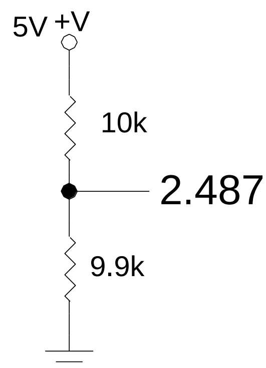
$$5\left(\frac{10}{19.9k}\right) = 2.512V$$

This output occurs just as the output switches H-.L; V_{in} Crosses 0 rising

b) The minimum is when Vin is at the maximum negative voltage, the − will be below + by 0.6V. In this condition + is at 2.512V so 2.512-0.6V = 1.912V

c) When Vin = 1V, the output will be low so:





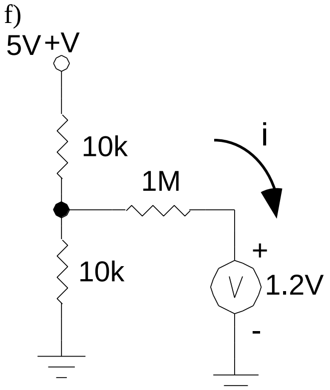
$$+ = 5\left(\frac{9.9}{19.9}\right) = 2.487V$$

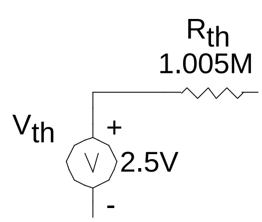
− will be 1 diode drop higher: 2.487V +0.6V = 3.087V

d) this is the same condition as in part #b: 1.912V

e) it won't change, therefore V=3.087V

f)





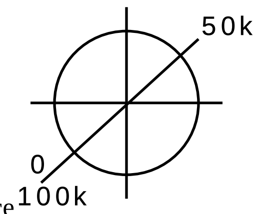
$$i = \frac{2.5-1.2}{1.005M\Omega} = 1.294\mu A$$

$$= 1.2V + 1.294\mu A * 1M\Omega = 2.494V$$

$$- = \quad - 0.6V = 2.494V - 0.6V = 1.894V$$

ME218a Final 1996 Problem #4

Direction:



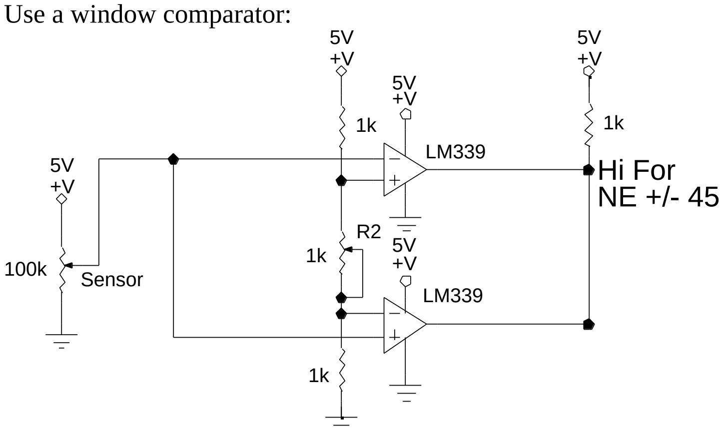
Orient the pot so that center scale = mid resistance

$$\frac{2.5V}{180^\circ} = 0.013\bar{8}V/^\circ \qquad 45^\circ = 0.625V$$

$$V_{min} = 2.5 - 0.625 = 1.875$$

$$V_{max} = 2.5 + 0.625 = 3.125V$$

Use a window comparator:



Let the lower R=1k then $i = \frac{1.875V}{1k} = 1.875mA$.

Then the middle $R = \frac{3.125 - 1.875}{1.875mA} = 666\Omega$; use a 1k pot.

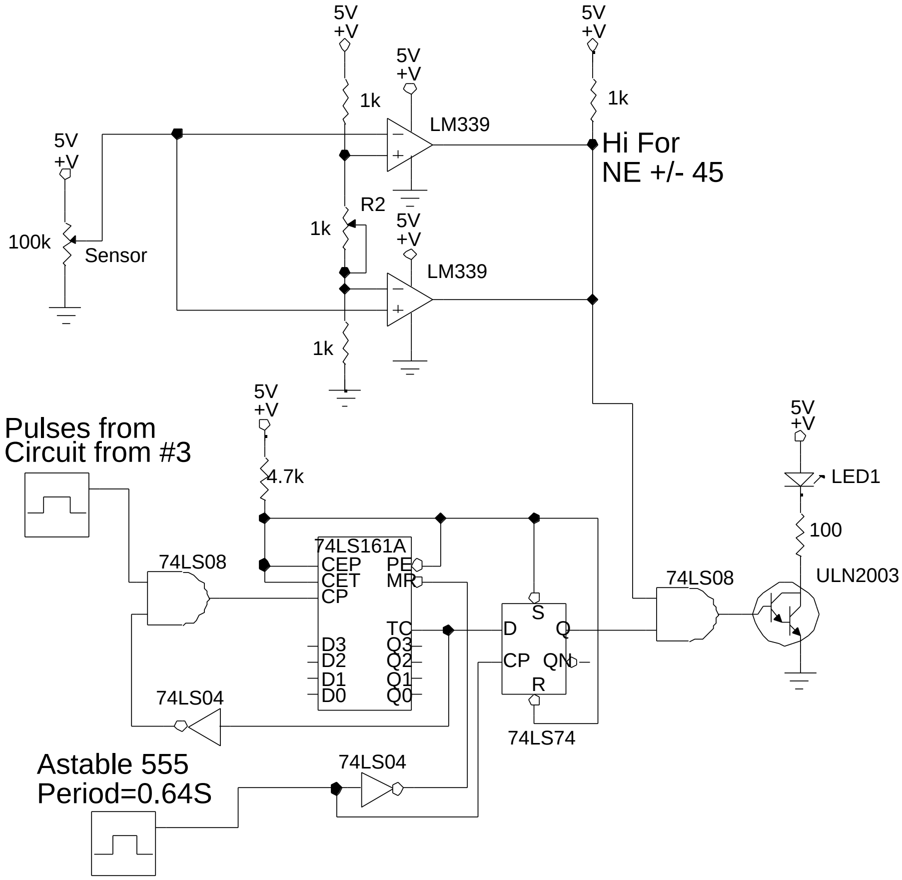
finally the upper $R = \frac{5 - 3.125}{1.875} = 1k$

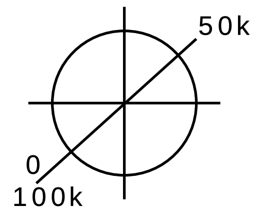
Speed:

The easiest solution here is to use the circuit from problem #3 to turn the output of the generator into a pulse train with a proportionality constant of 1Hz/MPH. Therefore at 25MPH f=25Hz.

If we feed that pulse train into a counter that is being periodically (period = 0.64S) reset by an astable 555, if the counter ever overflows, we know that the speed has exceeded the threshold. Unfortunately, the output of the overflow would pulse every time that the counter was reset. To avoid a pulsing indicator, use a flip-flop to latch the state of the overflow bit at each reset pulse.

Finally, take the direction and speed indicators and AND them to get the Nor'Easter logic indicator. This can drive a ULN2003 to light an LED:


5V
+V
1k
LM339
Hi For
NE +/- 45
R2
100k
Sensor
1k
1k
4.7k
Pulses from
Circuit from #3
74LS08
74LS161A
CEP
CET
CP
PE
MR
TC
Q3
Q2
Q1
Q0
D3
D2
D1
D0
S
D
Q
CP
QN
R
74LS74
74LS04
LED1
100
ULN2003
Astable 555
Period=0.64S


50k
0
100k