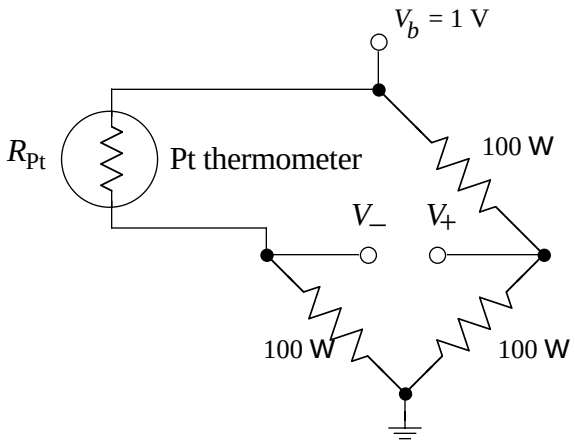
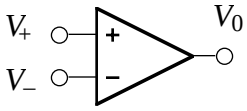
EECS 145L Final Examination Solutions (Fall 2000)

UNIVERSITY OF CALIFORNIA, BERKELEY
College of Engineering, Electrical Engineering and Computer Sciences Department

1a





Gain = 12

$V_+ - V_- = R/(2R) - R/(2R+\Delta R)$, R = 100 Ω

At 0°C $V_+ - V_- = 0$

At 100 °C $V_+ - V_- = 1/2$ V – 100/240 V = 0.0833 V

For V_0 = 1.0 V, need gain = 1 V / 0.0833 V = 12.

[an alternate solution used V_b = 12 V. This causes significant self-heating $P = V^2/100$ = 0.36 W but was accepted]

1b $V_0 = 12$ V $[1/2 - 100/(200 + 0.4T)]$

1c At 50 °C, $V_0 = 12$ V $[1/2 - 100/220] = 0.5454$ V

1d The linear response would be 0.500 V. The voltage deviation is 0.5454 V – 0.5000 V = 0.0454 V. Since the response slope is 100 °C per V, the temperature deviation is 4.54 °C.

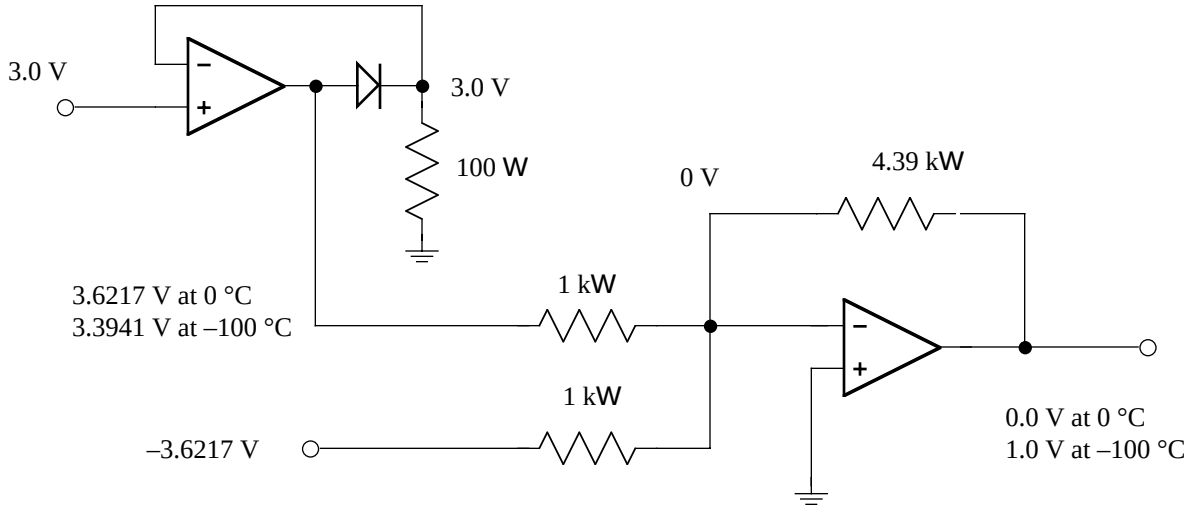
2a R = 3 V / 30 mA = 100 Ω

2b Since the ideal op-amp has infinite input impedance, $I_1 = 0$ and $I_2 = 0$. The virtual short rule gives V2 = V_1 = 0. So IR = 0 and since all the current through the op-amp, ID = 0 and V0 = 0V

2c I1 = 0, I2 = 0, V2 = 3 V, IR = 30 mA, ID = 30 mA, V_D = 0.6217 V, V0 = 3.6217 V.

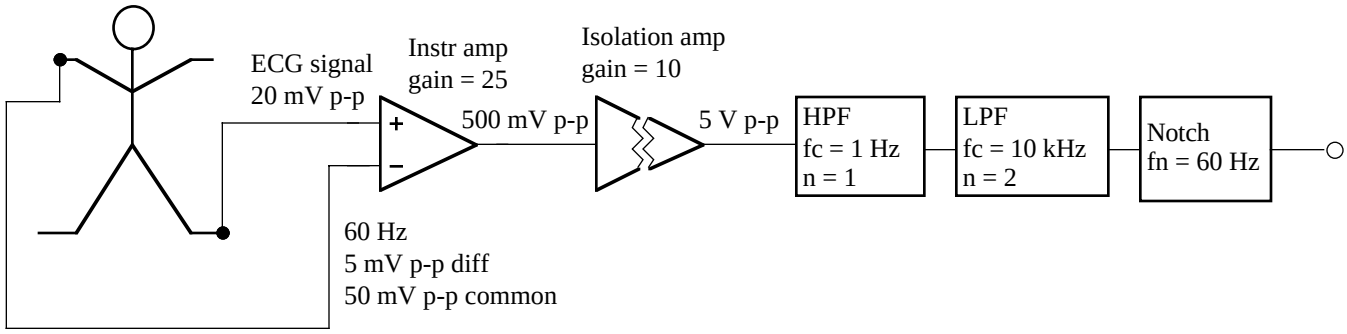
2d I1 = 0, I2 = 0, V2 = 3 V, IR = 30 mA, ID = 30 mA, V_D = (173/273) 0.6217 V = 0.3940, V0 = 3.3940 V.

3 V0 decreases by 0.228 V from 0°C to –100 °C so a gain of –4.39 is needed to produce 0 V at 0 °C and 1.0 V at –100 °C.



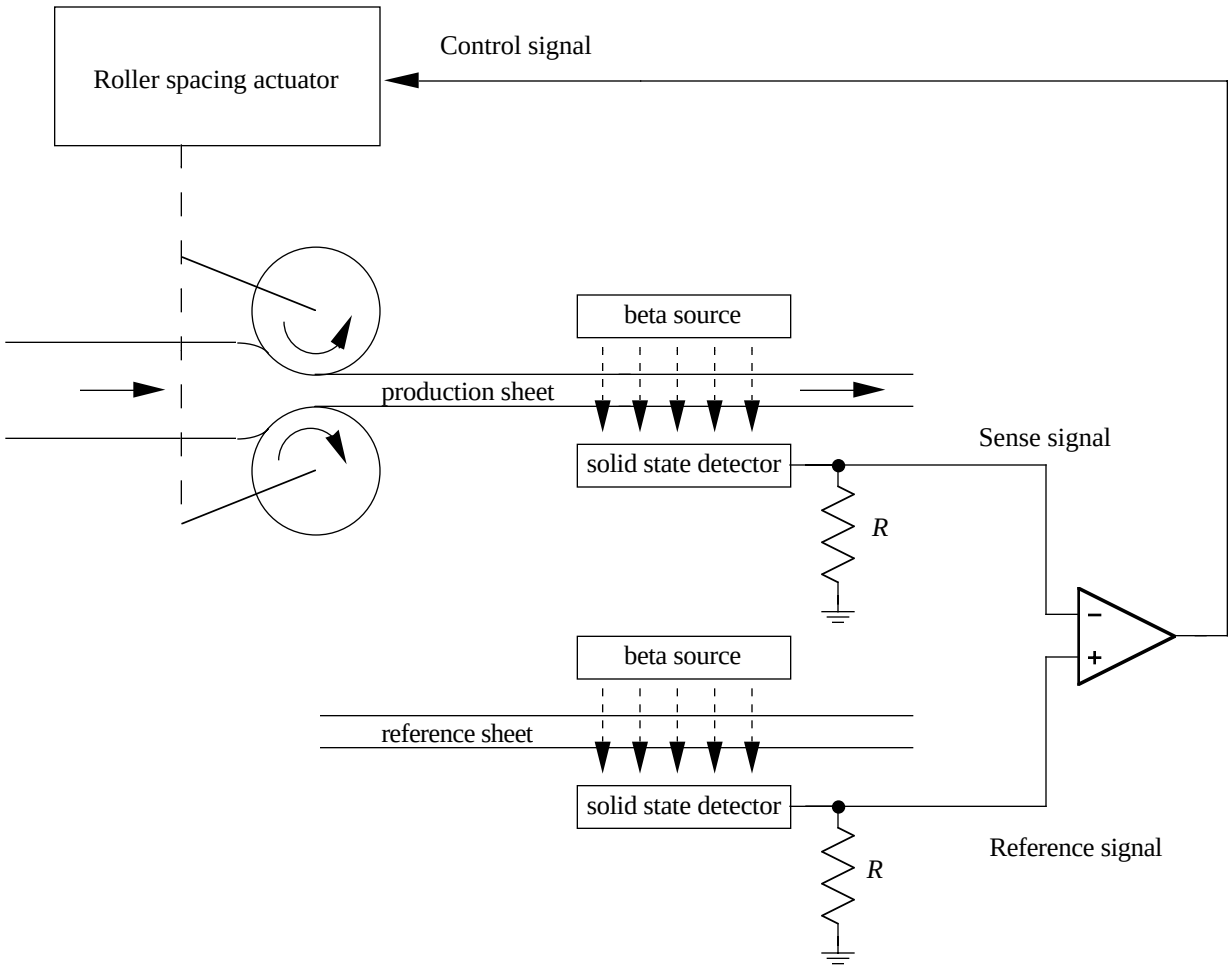
[Either the op-amp adder circuit and the instrumentation amplifier were accepted]

4



[5 points off for each element missing]
[4 points off if filter order not given] [2 points off for excessively large number of filter stages]
[5 points off if differential ECG signal not amplified in a differential way- isolation amplifier or instrumentation amplifier could come first but not filters]
[4 points off if 5 V ECG p-p signal not produced] [4 points off for no voltage values]

5a



[4 points off if no solid state detector current to voltage conversion]
[4 points off if sheets are not between beta source and detector]

5b

1 The thinner reference sheet absorbs less beta energy

2 the reference solid state detector current increases

3 This increases the voltage on the positive input of the difference amplifier and increases the error voltage.

4 This input to the controller decreases the spacing between the rollers and produces thinner sheets.

5 The spacing is stable when the output sheet has the same thickness as the reference sheet.

145LFinal Examination score distribution:

101-110 1U	111-120 0	121-130 0
131-140 1U	141-150 0	0151-160 0
161-170 3U	171-180 0	181-190 1U
191-200 6U, 2G		

undergraduate (U) average = 175.3
graduate (G) average = 200

145L Course Grade Distribution

Grade	Undergraduate Scores	Graduate Scores
A +	914	944
A	899, 894	888
A –	877, 860	
B +	831, 830	
B	818	
B –	777. 763, 761	
C +		
C	702	
C –		
Maximum	1000	1000
Average	827	916