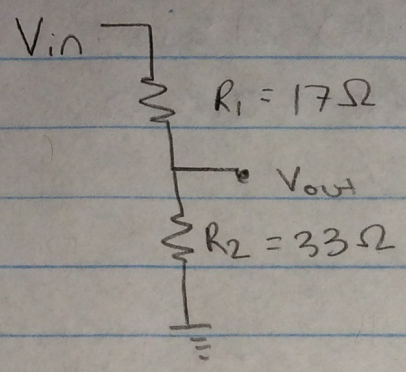
GSA #2

9/10/15



(#1) $V_{out} = \frac{R_2}{R_1+R_2}(V_{in})$

$3.3 = \frac{R_2}{R_1+R_2}(5)$

$.66 = \frac{33}{17+33}$

$.66 = \frac{33}{50}$ $\boxed{R_2 = 33\Omega}$

$R_1 + R_2 = 50$

$R_1 + 33 = 50$ $\boxed{R_1 = 17\Omega}$

(#2) Approx: $\frac{17}{33} = \frac{R_1}{R_2}$

$\boxed{R_1 = 220\Omega}$
$\boxed{R_2 = 430\Omega}$

$V_{out} = \frac{R_2}{R_1+R_2}(V_{in}) = \frac{430}{220+430}\,5V = 3.3V$

(#3) $R_{tot} = R_1 + R_2 = 220 + 430 = 650\Omega$

$V = IR \Rightarrow I = V_{in}/R_{tot} = 5V/650\Omega = 0.0077A$

$P_{R_1} = I^2R = 0.0077^2 \times 220\Omega$

$= \boxed{0.013\,W}$

$P_{R_2} = I^2R = 0.0077^2 \times 430\Omega$

$= \boxed{0.025\,W}$

#4 $R_1 = 220\Omega$ $R_2 = 430\Omega$

$220(.05) = 11\Omega$ $430(.05) = 21.5\Omega$

$R_1 = 220 \pm 11\Omega$ $R_2 = 430 \pm 21.5\Omega$

V_{out} both low $= 3.31V$

V_{out} both high $= 3.31V$

V_{out} R_1 low, R_2 high $= 3.42V$

V_{out} R_1 high, R_2 low $= 3.19V$

$$V_{out\ R_1 low / R_2 high} = I_{tot} R_{tot} \Rightarrow I_{tot} = \frac{R_2}{R_1 + R_2} V_{in}$$

(#5)

2.5V @ 0°C

$\alpha = \frac{10mV}{°C} \times \frac{V}{1000mV} = \frac{0.01mV}{°C}$

$\Delta T = T_S - T_i = 40 - 0 = 40°C$

$\frac{0.01mV}{°C} \times 40°C = 0.4V$

$V = V_i + \Delta V = 2.5 + 0.4 = 2.9V$

$V_{in} = 2.9V$

$V_{out} = V_{in} - V_{R1} = 2.9 - V_{R1}$

$V_{R1} = I_{TOT} \cdot R_1$

$I_{TOT} = V_{in} / R_{TOT}$

$R_1 = 209\Omega$ $R_2 = 451.5$

$R_{TOT} = 660.5\Omega$

$I_{TOT} = 2.9V / 660.5\Omega$

$= 0.0044A$

$V_{R1} = 0.0044A (209\Omega)$

$= 0.92V$

$V_{OUT} = 2.9 - .92V$

$= 1.98V$

$R_1 = 231\Omega$ $R_2 = 408.5\Omega$

$R_{TOT} = 639.5\Omega$

$I_{TOT} = 2.9V / 639.5\Omega$

$= 0.0045A$

$V_{R1} = 0.0045A (231\Omega)$

$= 1.05V$

$V_{OUT} = 2.9 - 1.05V$

$= 1.85V$

Voltage Range
= 1.85V - 1.98V

(#6) Uncert. 1% per °C

10mV = 0.01V

1% : 0.01 x 0.01 = 0.0001V

$\Delta T = 40°C$ so $40(.0001) = 0.004V$

$$V_{out} = V_{in} - V_{R_1} = 2.5 + V_{calc} - V_{R_1}$$

$$V_{R_1} = I_{tot} R_1$$

$$I_{tot} = V_{in} / R_{TOT}$$

$$V_{out} = 2.5V + V_{calc} - (2.5 + V_{calc}) R_1 / R_{tot}$$

- Uncertainty R_{TOT}

$$R_{TOT} = R_1 + R_2$$

$$\delta_{R_{TOT}, R_1} = \delta_{R_1} = 0.05(220\Omega) = 11\ \Omega$$

$$\delta_{R_{TOT}, R_2} = \delta_{R_2} = 0.05(430\Omega) = 21.5\ \Omega$$

$$\delta_{R_{TOT}} = \sqrt{(\delta_{R_{TOT}, R_1})^2 + (\delta_{R_{TOT}, R_2})^2} = \sqrt{11^2 + 21.5^2}\Omega = \pm 24.15\Omega$$

$$\delta_{V_{out}, R_{TOT}} = \frac{(2.5 + V_{calc}) R_1}{(R_{TOT})^2} \delta_{R_{TOT}} = 0.036V$$

$$\delta_{V_{out}, R_1} = -\frac{(2.5 + V_{calc})}{R_{TOT}} \delta_{R_1} = -0.049V$$

$$\delta_{V_{out}, V_{calc}} = \delta_{V_{calc}} + \frac{R_1}{R_{TOT}} \delta_{V_{calc}} = 0.005V$$

$$\delta_{V_{out}} = \sqrt{\delta_{V_{out}, R_{TOT}}^2 + \delta_{V_{out}, R_1}^2 + \delta_{V_{out} V_{calc}}^2} = \boxed{\pm 0.06\ V}$$