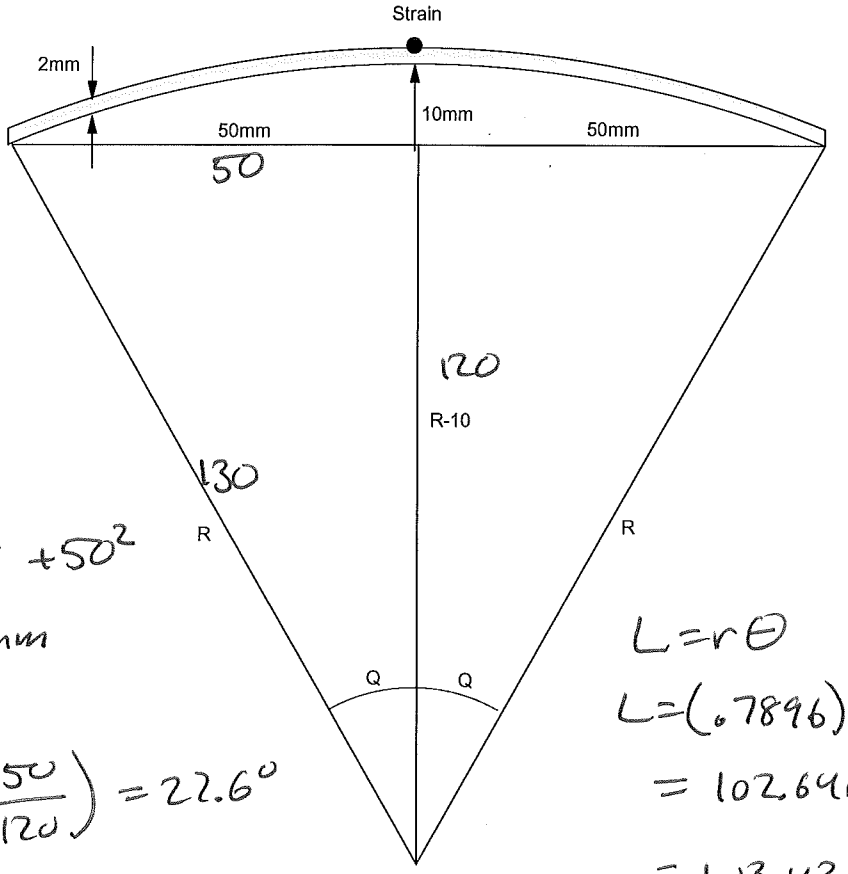
# ECE 321 - Quiz #2 - Name _____

Push-Pull Amplifiers, Op-Amp Amplifiers, November 8, 2018

1) An accelerometer uses the deflection of a beam to measure acceleration. Calculate the strain on the beam when the deflection is 10mm. Assume the beam is 100mm long and 2mm thick.

| Radius R | Arc Length 2Q | Length of Deflected Beam (L) | Strain dL / L |
|---|---|---|---|
| | | | |

130mm  45.23°  .7896 rad  $L = r\theta$  103.43mm outer  102.64mm center  +.0077 free end  +0.0343 fixed end




$R^2 = (R-10)^2 + 50^2$

$R = 130mm$

$Q = \text{atan}\left(\frac{50}{120}\right) = 22.6°$

$2Q = 45.23°$

$L = r\theta$

$L = (.7896)(130mm)$

$= 102.64mm$ center

$= 103.43$ outer

$\varepsilon = \frac{103.43 - 102.64}{102.64}$

$= +0.0077$

$= \frac{1}{130}$

2) Assume the strain goes from 0 .. 0.03. Design a circuit which has an output of

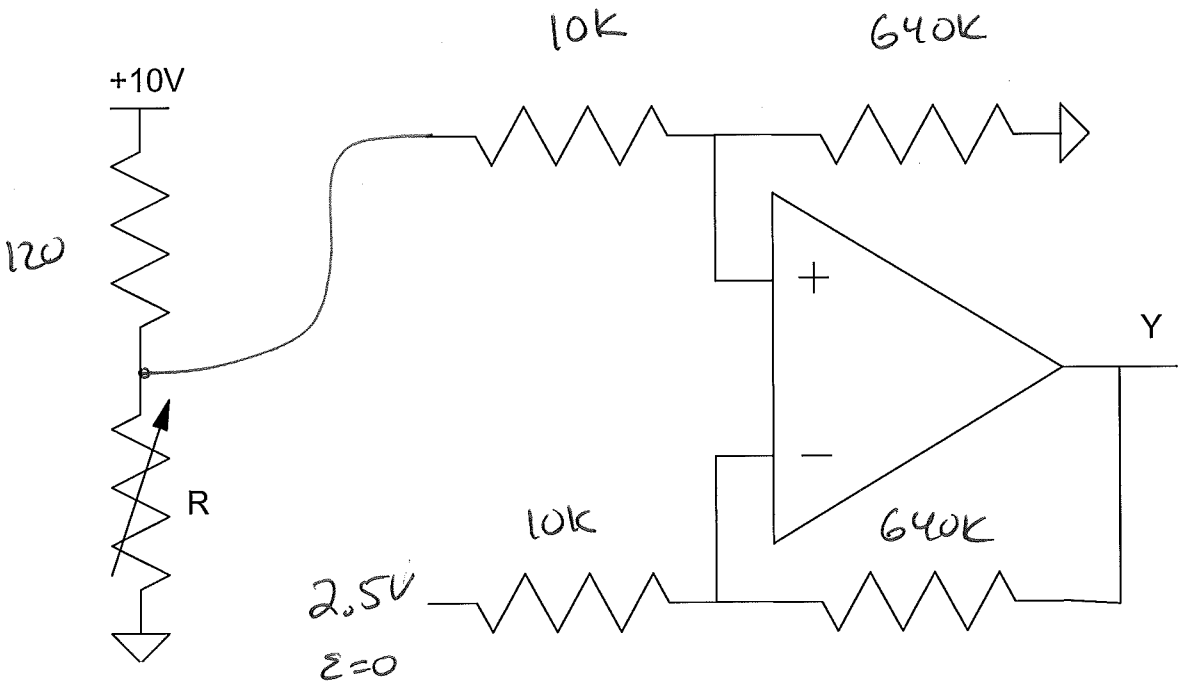
- $Y = 10V$ for $\varepsilon = 0.03$
- $Y = 0V$ for $\varepsilon = 0$

Assume the strain sensor has a resistance of

$$R = 120 \cdot (1 + 2.14\varepsilon)\ \Omega$$

$= 127.70\ \Omega$ $(\varepsilon = .03)$

$= 120$ $(\varepsilon = 0)$



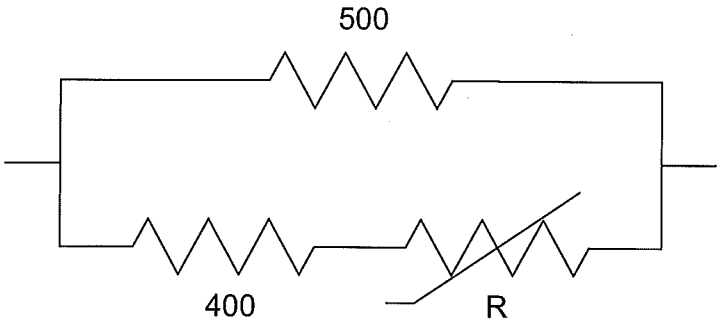

$V(12.7) = 2.5778V$

$$\text{gain} = \frac{10}{2.5778 - 2.5} = 64$$

3) Linearizing Circuit: The following circuit is intended to linearize the resistance between 0C and +40C. Determine the net impedance at 0C, 20C, and 40C as well as the "error" in this linearizing circuit

$$R = 1000 \cdot \exp\left(\frac{3905}{K} - \frac{3905}{298}\right)$$

| Z(0C) (273K) (R = 3320 Ohms) | Z(20C) (293K) (R = 1250 Ohms) | Z(40C) (313K) (R = 534 Ohms) | Sum Squred Error $E = \left(Z_{20C} - \frac{Z_{0C}+Z_{40C}}{2}\right)^2$ |
|---|---|---|---|
| 440.75 | 383.72 | 325.66 | .2607 |



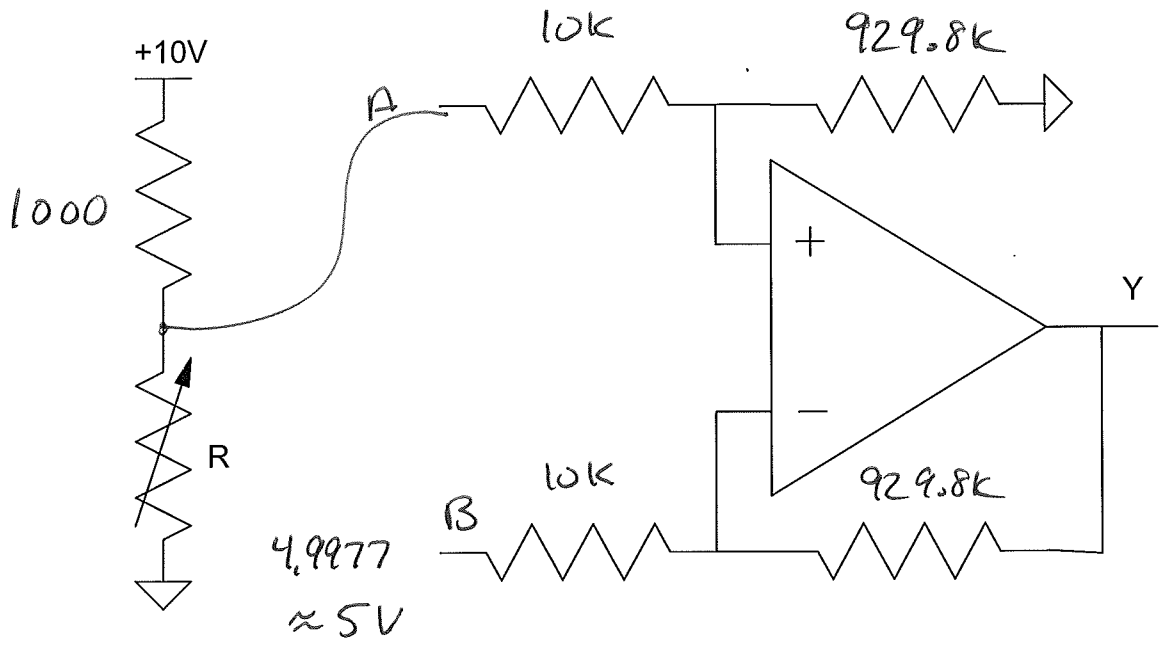

$$Z_{eq} = \left(\frac{1}{R+400} + \frac{1}{500}\right)^{-1}$$

4) Assume an RTD has a resistance vs. temperatuer relationship of

$$R = 1000 \cdot (1 + 0.0043T)\ \Omega$$

where T is the temepratuer in degrees C. Design a circuit which outputs

- Y = -10V at T = -10C and
- Y = +10V at T = +10C




$-10°$

$R = 957$

$V = 4.89$

$+10°$

$R = 1043$

$V = 5.1052$

$$\text{gain} = \frac{20V}{5.1052 - 4.89} = 92.98$$

$$y = 92.98(A - B)$$

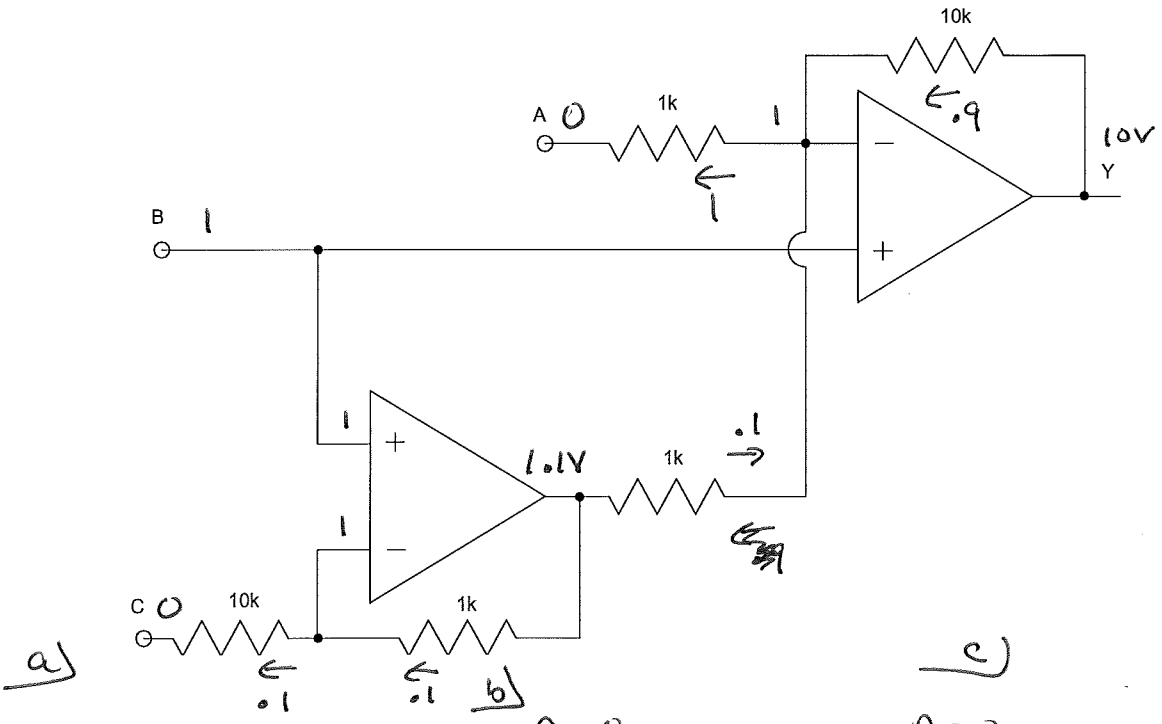
$$10 = 92.98(5.1052 - B)$$

$$B = 5V$$

5) For the following amplifier, determine the gains {a, b, c}

$$Y = aA + bB + cC$$

| a | b | c |
|---|---|---|
| -10 | +10 | +1 |




a)

A=1
B=0
C=0

y = -10V

a=-10

b)

A=0
B=1
C=0

y=10V

b=10

c)

A=0
B=0
C=1

y=+1

c=1

Industrial Help Bonus! Hemp-based plastics take 3-6 months to decompose. How long do petroleum-based plastics to decompose?

≈450 years (plastic bottle)

1000+ years plastic bags