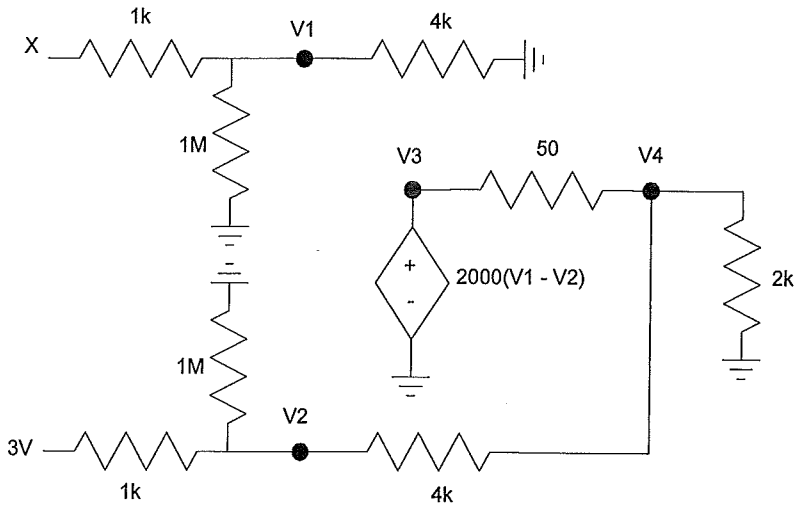
ECE 321 - Quiz 1: Name _____

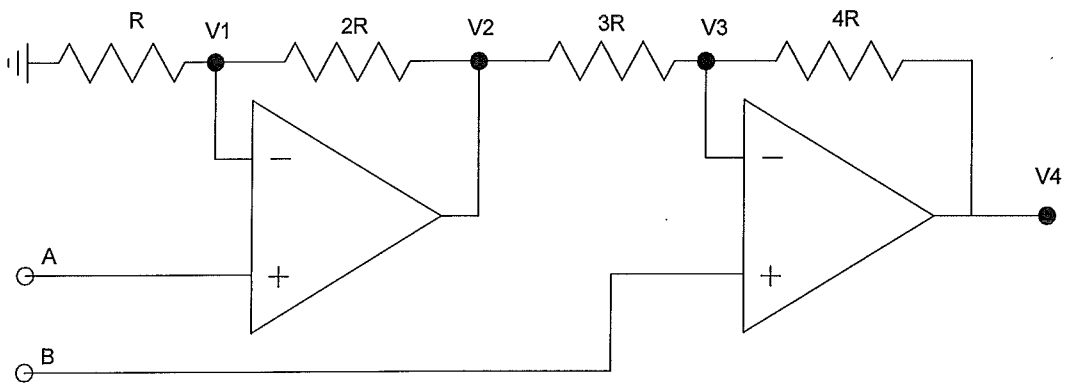
Op-Amps. April 8, 2015

1) Write the voltage node equations for the following op-amp circuit:



Node V1: $\frac{V_1 - X}{1k} + \frac{V_1}{4k} + \frac{V_1}{1m} = 0$
Node V2: $\frac{V_2 - 3}{1k} + \frac{V_2}{1m} + \frac{V_2 - V_4}{4k} = 0$
Node V3: $V_3 = 2000\,(V_1 - V_2)$
Node V4: $\frac{V_4 - V_2}{4k} + \frac{V_4 - V_3}{50} + \frac{V_4}{2k} = 0$

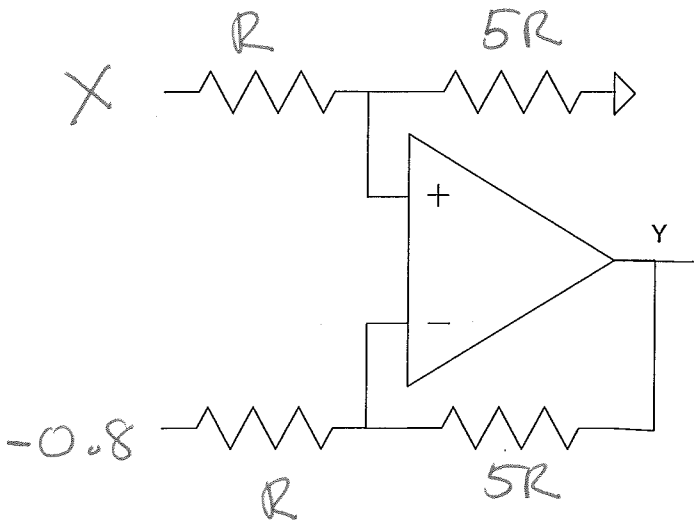
2) Assume ideal op-amps. Write the voltage node equations for the following circuit.



Node V1: $\frac{V_1}{R} + \frac{V_1 - V_2}{2R} = 0$
Node V2: $V_1 = A$
Node V3: $\frac{V_3 - V_2}{3R} + \frac{V_3 - V_4}{4R} = 0$
Node V4: $V_3 = B$

3) Specify the resistors and voltages so that the following circuit implements the funciton

$y = 5x + 4$



$y = 5(x + 0.8)$

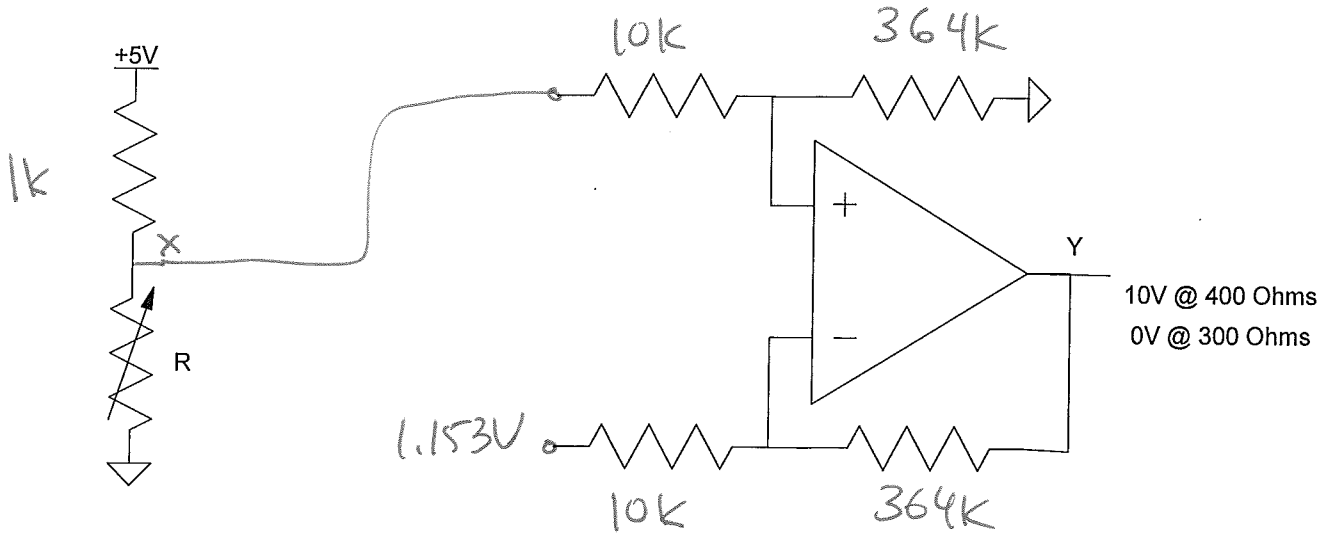
$y = 5(x - (-0.8))$

R = anything (1k, 10k, ...)

4) Specify the resistors and voltages so that the following circuit outputs

0V when R = 300 Ohms, and

+10V when R = 400 Ohms



300Ω

X = 1.1538V

402Ω

X = 1.4286V

gain=36.4

many solutions

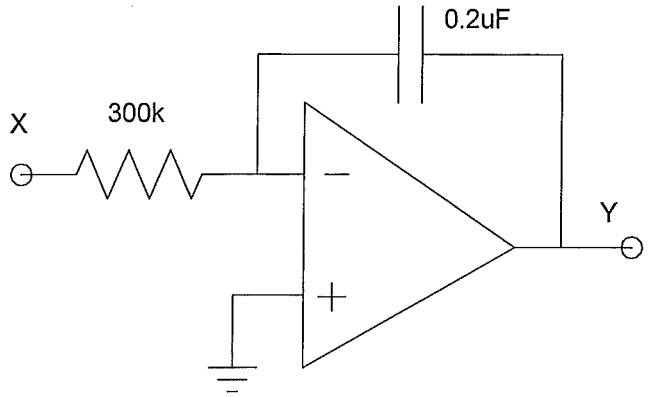
- gain = $\frac{10V}{V_{400} - V_{300}}$

- offset = V_{300}

5) For the following circuit,

- Find the differential equation relating X and Y.
- Find y(t) assuming $x(t) = 2\sin(3t) + 4\cos(200t)$

Differential equation relating X and Y
$y = -16.67 \int x\,dt$ or $\frac{dy}{dt} = -16.67x$
y(t)
$11.11\cos(3t) - .333\sin(200t)$



$$y = -\frac{1}{RC}\frac{1}{s}X$$

$$y = -16.67 \int x\,dt$$

$$y = -16.67\left[-\frac{2}{3}\cos(3t) + \frac{4}{200}\sin(200t)\right]$$

Bonus: There is some concern about railways carrying oil and other flammable material through cities. When can a railway refuse to carry cargo if the railway engineers feel it is unsafe?

no - railways cannot refuse any cargo as long as it meets federal regulations