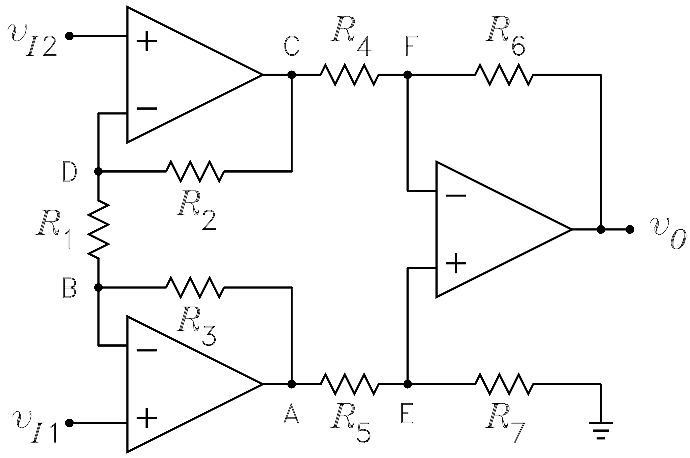
ECE 3050 Analog Electronics Quiz 11
April 1, 2009

Professor Leach Name__________________________________

Instructions. Print your name in the space above. **Honor Code:** *I have neither given nor received help on this quiz.* Initials ____________

1 of 2. The figure shows a three op amp instrumentation amplifier. It is given that $v_{I1} = 1.5\,\text{V}$, $v_{I2} = -2\,\text{V}$, $R_1 = 1\,\text{k}\Omega$, $R_2 = 2\,\text{k}\Omega$, $R_3 = 3\,\text{k}\Omega$, $R_4 = 4\,\text{k}\Omega$, $R_5 = 5\,\text{k}\Omega$, $R_6 = 6\,\text{k}\Omega$, and $R_7 = 7\,\text{k}\Omega$. Solve for the node voltages v_A through v_F and the output voltage v_O.



$v_{I1} := 1.5$ $\quad v_{I2} := -2$ $\quad R_1 := 1000$ $\quad R_2 := 2000$ $\quad R_3 := 3000$ $\quad R_4 := 4000$

$R_5 := 5000$ $\quad R_6 := 6000$ $\quad R_7 := 7000$

$v_A := \left(1 + \frac{R_3}{R_1}\right) \cdot v_{I1} - v_{I2} \cdot \frac{R_3}{R_1}$ $\quad v_A = 12$ $\quad v_B := v_{I1}$ $\quad v_B = 1.5$

$v_C := -v_{I1} \cdot \frac{R_2}{R_1} + \left(1 + \frac{R_2}{R_1}\right) \cdot v_{I2}$ $\quad v_C = -9$ $\quad v_E := v_A \cdot \frac{R_7}{R_5 + R_7}$ $\quad v_E = 7$

$v_F := v_E$ $\quad v_F = 7$ $\quad v_O := v_E \cdot \left(1 + \frac{R_6}{R_4}\right) - v_C \cdot \frac{R_6}{R_4}$ $\quad v_O = 31$

2 of 2. (a) A circuit has the differential equation $\ddot{v}_O + 3\dot{v}_O + 4v_O = 8v_I$, where each dot indicates a time derivative. Solve for the transfer function for V_o/V_i.

$$s^2 V_o + 3sV_o + 4V_o = 8V_i \Longrightarrow \frac{V_o}{V_i} = \frac{4}{s^2 + 3s + 4} = \frac{1}{(s/2)^2 + (3/2)(s/2) + 1}$$

(b) Sketch and label the Bode magnitude and phase plots for the transfer function

$$T(s) = \frac{K}{(1 + s/\omega_0)(1 + s/r\omega_0)}$$

where r is a number such that $r\omega_0 \gg \omega_0$.

Magnitude: Starts at K at zero frequency, breaks to -1 dec/dec at $\omega = \omega_0$, and breaks to -2 dec/dec at $\omega = r\omega_0$.
Phase: Starts at 0°, approaches -90° between ω_0 and $r\omega_0$, and approaches -180° well above $r\omega_0$.