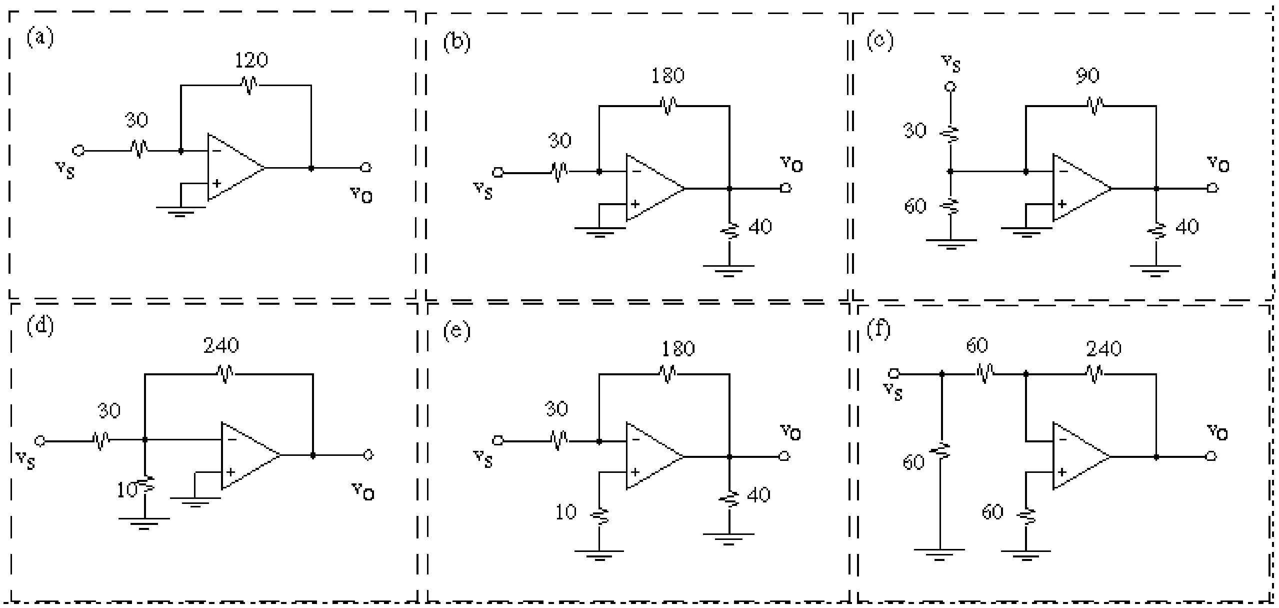
Ain Shams University
Faculty of Engineering

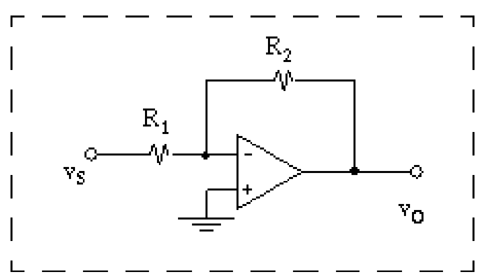
MCT242
Sheet 1

Sheet 1
Opamp Circuits and Filters

Problem 1:
Assume ideal opamps determine the voltage transfer gain $T = v_O/v_S$ and input resistance R_{in} for each of the configurations by inspection. (Resistances are in kΩ).

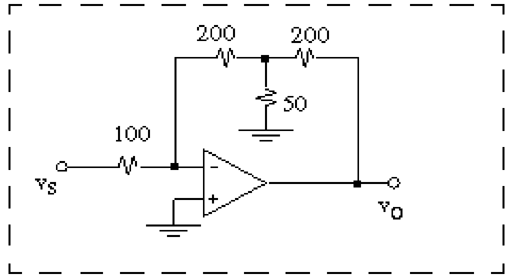


Problem 2:
(a) Using resistances no larger than 1.0 MΩ design an amplifier with gain -20 V/V and the largest possible R_{in}, using the inverting configuration. Assume ideal opamp. (b) What is the input resistance ?

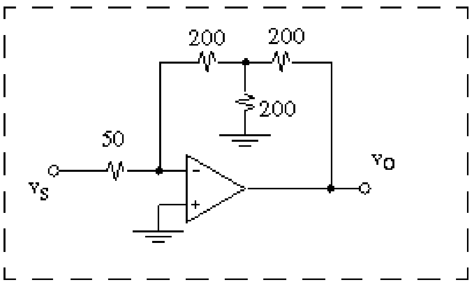


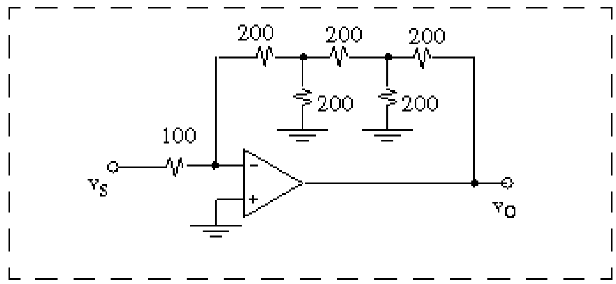
Problem 3:
Find
(a) transfer function $T = v_O/v_S$ and
(b) input resistance R_{in}.

(Resistances are in kΩ)

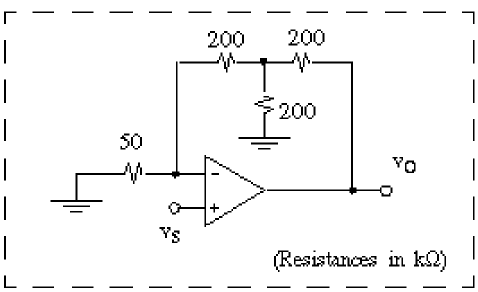


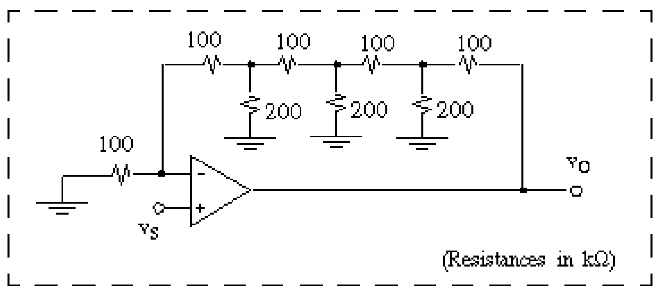
Problem 4
Find (a) transfer gain $T = v_O/v_S$ and (b) input resistance R_{in}



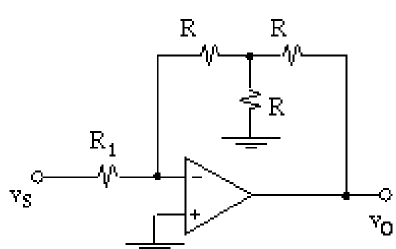


Problem 5:
Find transfer gain $T = v_O/v_S$, input resistance R_{in}

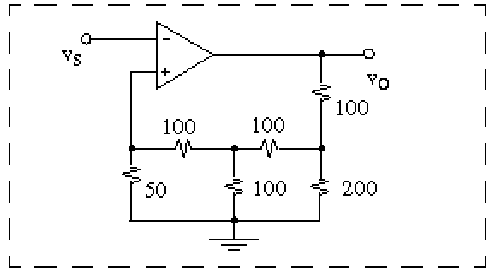




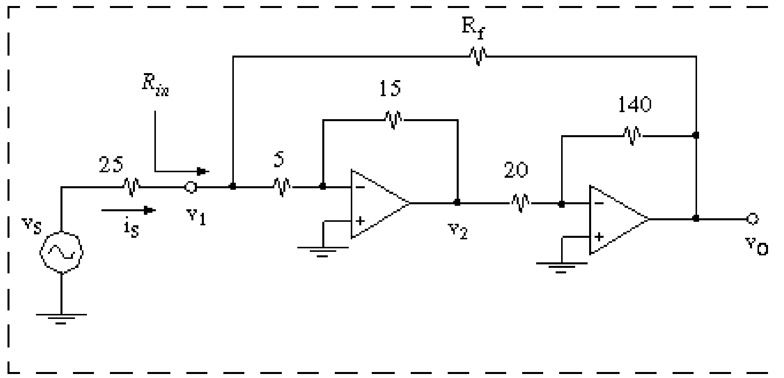
Problem 6:
(a) Using the inverting configuration with single-tee feedback (as shown) and resistances no larger than 600 kΩ, design an amplifier with gain -12 V/V and the largest possible R_{in}. Assume ideal opamp.
(b) What is the R_{in}?



Problem 7:
Find the transfer function $T = v_O/v_S$



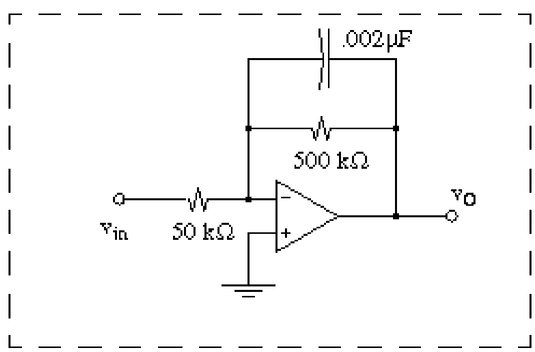
Problem 8:
Determine input resistance R_{in} and transfer gain v_O/v_S for the circuit shown, assuming that
(a) $R_f = \infty$
(b) $R_f = 100\text{k}\Omega$



Problem 9:
A sinusoidal input with phase shift $\phi = 0$ is fed to a Miller integrator that uses an ideal opamp and an RC pair with $R = 100\ \text{k}\Omega$ and $C = .001\ \mu\text{F}$.

(a) At what frequency are the input and output signals equal in magnitude?
(b) What is the phase of V_O relative to V_{in}?
(c) If the frequency is decreased by a factor of 10 from that of part (a), by how many dB does the output change?

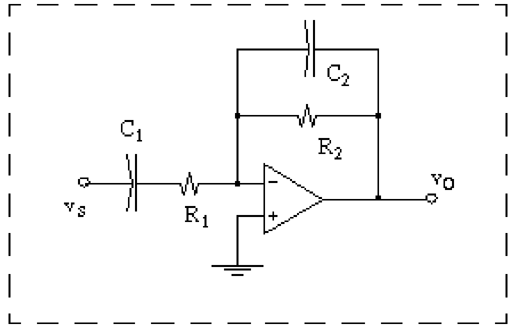
Problem 10:
A lossy Miller integrator, as shown, uses an ideal opamp.
(a) Plot the Bode magnitude plot of this circuit



A sinusoidal signal is applied to the input.
(b) at what frequency are the input and output signals equal in magnitude?
(c) What is the phase of v_o relative to v_{in} for part (a)?
(d) If the frequency is decreased by a factor of 10 from that of part (b), by how many dB does the output change?

Problem 11:

(a) Show that the transfer function for the configuration shown is



$$T = \frac{-R_2/R_1}{(1+p_1/s)(1+s/p_2)}$$

where $p_1 = 1/R_1C_1$ and $p_2 = 1/R_2C_2$, $s = j\omega$

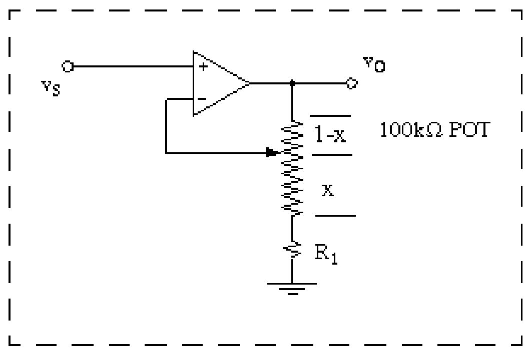
The circuit has the frequency response of a bandpass, for which the low-frequency 3dB rolloff is at p_1 and the high-frequency 3dB rolloff is at p_2

(b) By choice of R_1, R_2, C_1, C_2, design a circuit for which R_{in} = 25 kΩ, midband gain = 34 dB, low-frequency rolloff = 200Hz and upper frequency rolloff = 20 kHz.

(c) Draw the Bode plot of the circuit designed in (b)

Problem 12:

The circuit shown uses a 100kΩ potentiometer to devise an adjustable gain amplifier.



(a) Assuming $R_1 = 0$, derive an expression for the gain as a function of parameter setting x.

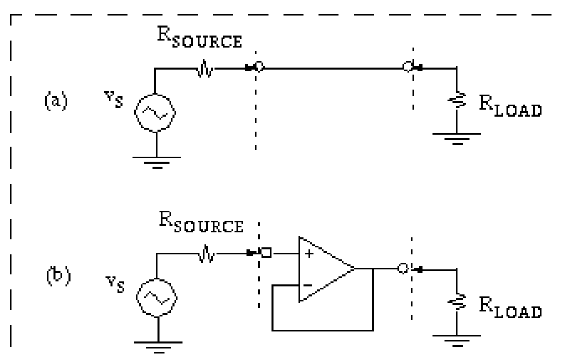
(b) What value of R_1 is necessary so the gain will range from $T = 1$ to $T = 10$ V/V?

Problem 13:

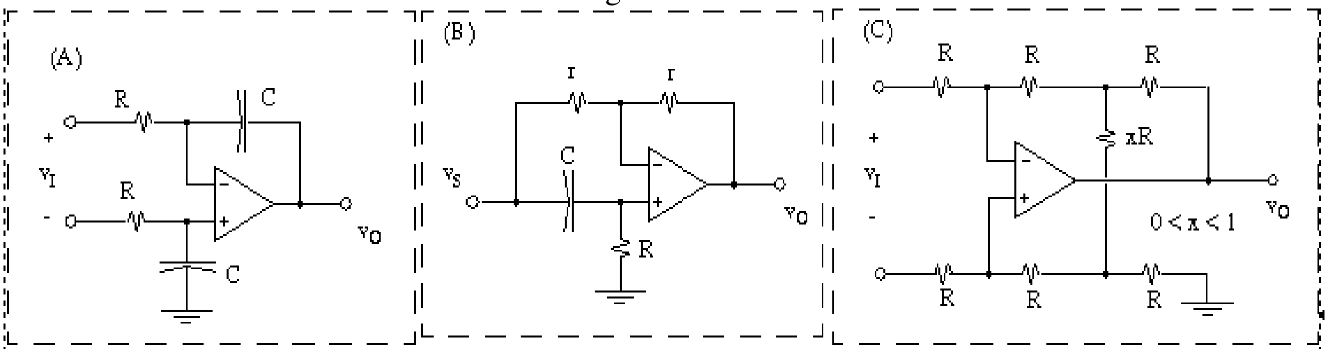
A photodetector with source voltage 100 mV and source resistance 100 kΩ is connected to a 1 kΩ load. Find the voltage that will appear across the load if:

(a) it is connected directly to the load.

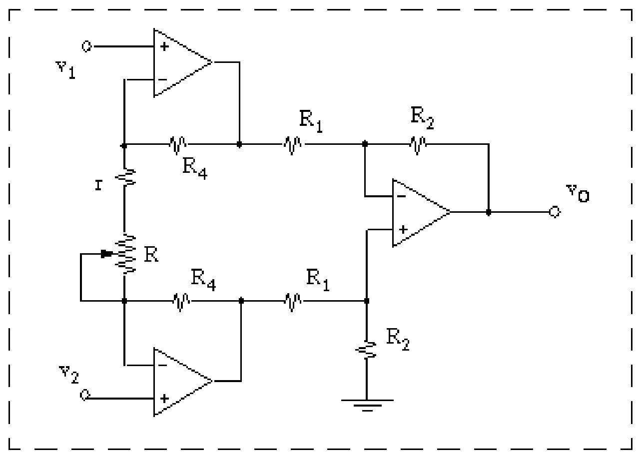
(c) an ideal unity-gain buffer is inserted between the source and the load (as shown).



Problem 14:
Find transfer functions for each of the following circuits

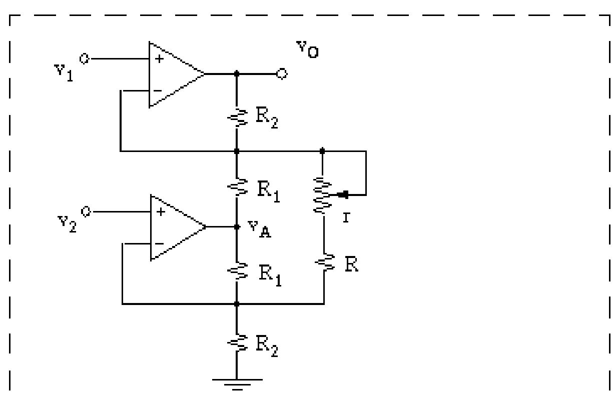


Problem 15:
Design the topology values of instrumentation amplifier (IA) such that it will realize a (differential) gain 1 to 50 with R = 100 kΩ potentiometer configured as a variable resistance. *Suggestion:* Design the second stage with gain of 0.5V/V.



Problem 16:
(a) Using nodal analysis show that the circuit shown will give a single-ended differential amplifier. Find the transfer gain.

(b) Design the single-ended instrumentation amplifier shown such that it will realize a differential gain that is variable in the range 10 to 50 using a 100 kΩ potentiometer as a variable resistance. (hint: Let $R_2/R_1 = 1$)



Problem 17:

Assuming ideal opamps determine the 3dB rolloff frequency for the following 4-stage circuit in terms of the time constant $\tau = RC$. (*Hint:* Assume each stage loses 3/4 dB)