

EE2002
TUTORIAL 1 (with answers at the back)

1. Find an expression for v_{OUT} as a function of v_1 and v_2 in each of the op-amp circuits of Fig.T1-1 and also determine the input resistance(s) for each of the op-amp circuits. Assume op-amps used are ideal.

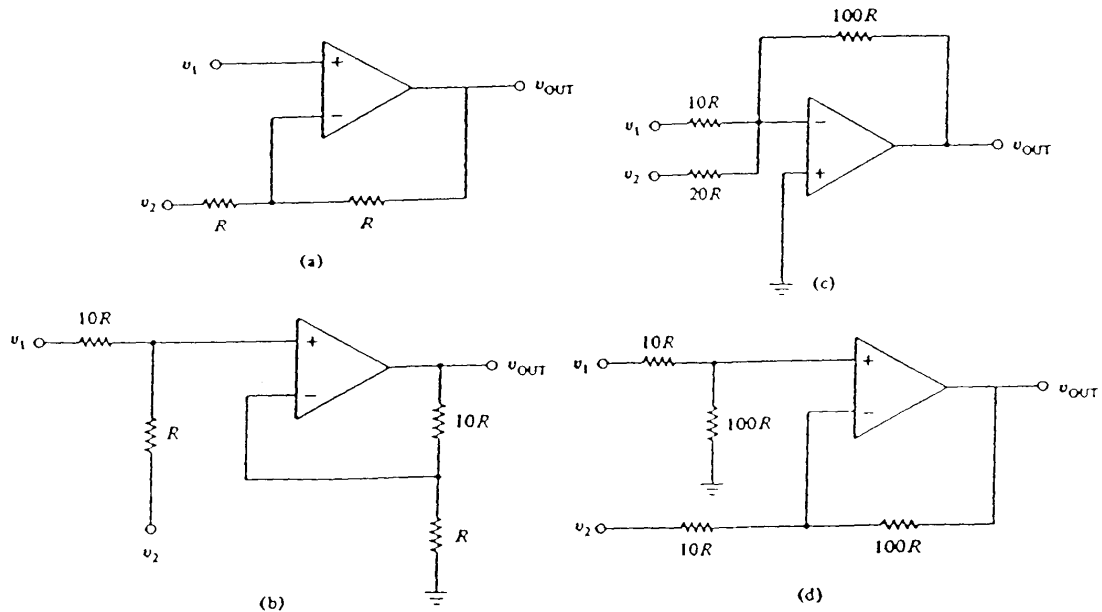


Fig T.1-1

2. Consider an op-amp follower (i.e. the output is connected to the negative input) powered by $\pm 15V$ supplies. The input voltage is set to $1V$ and the output feeds a $100\ \Omega$ resistive load R_L . With R_L disconnected, the current I_p from V_{CC} into the op-amp equals the current I_N from the op-amp into V_{EE} . The op-amp used is assumed to be ideal.
- Draw a diagram of this circuit. Label the current I_p and I_N .
 - What is the difference between the power supply currents I_p and I_N when R_L is connected?
 - Find the additional power drawn from the power supplies when R_L is connected.
3. A high-gain op-amp circuit is formed by cascading two inverting amplifiers in series. Both op-amps are connected to $\pm 15V$ power supplies. The first stage has gain of 20. The cascade is to be designed so that the peak output voltage of the second stage comes no closer than $1V$ to either power supply voltage. If the input is equal to a 25-mV peak sinusoid, what is the maximum permissible gain of the second stage if its output is to remain within its allowed swing limits? Assume op-amps used are ideal.

4. Find an expression for v_{OUT} in the circuit shown in Fig T1-2. Assume the op-amp used is ideal.

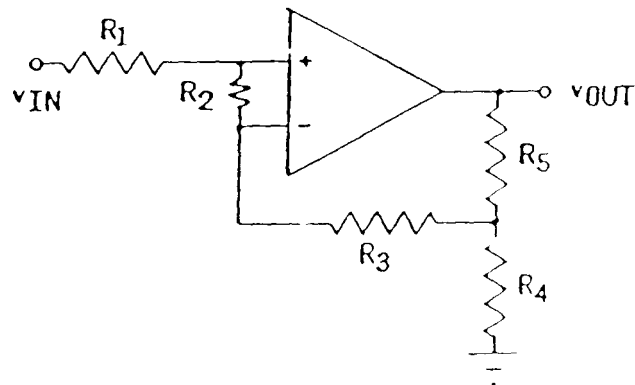


Fig. T 1-2

5. An inverting amplifier with a gain of -10 is made from a nonideal op-amp having an input offset voltage of 1mV. A sinusoidal input voltage of 0.1mV peak amplitude is applied. What are the resulting ac and dc components of the output voltage?
6. A difference amplifier with a gain of 2 is made from an op-amp with the following parameters: $V_{IO}=2\text{mV}$ maximum; $I_{BIAS}=100\text{nA}$; $I_{IO}=0$. If both inputs are set to zero, what is the maximum expected offset value of v_{OUT} ?

Partial Answers to Tutorial 1

1

(a) $V_{OUT} = 2v_1 - v_2$

$R_{in1} = \infty$

$R_{in2} = R$

(b) $V_{OUT} = v_1 + 10 v_2$

$R_{in1} = 11R$

$R_{in2} = 11R$

(c) $V_{OUT} = -(10v_1 + 5 v_2)$

$R_{in1} = 10R$

$R_{in2} = 20R$

(d) $V_{OUT} = 10(v_1 - v_2)$

$R_{in1} = 110R$

$R_{in2} = 10R$

2. (b) $I_P - I_N = 10 \text{ mA}$

(c) The additional power drawn from V_{CC} is

$\Delta P = 150 \text{ mW}$

No additional power is drawn from V_{EE} , the negative supply.

3. The maximum permissible gain of the second stage is 28.

4. $v_{OUT} = \left(\frac{R_5 + R_4}{R_4} \right) v_{IN}$

5. $v_{OUT} = \sum_{i=1}^2 (v_{OUT})_i = (-1 \sin \omega t + 11) \text{ mV}$

6. $v_{OUT} = 6 \text{ mV}$