EE2002 2014/2015

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) with respect to ground for each of the op-amp circuits. Assume op-amps used are ideal.

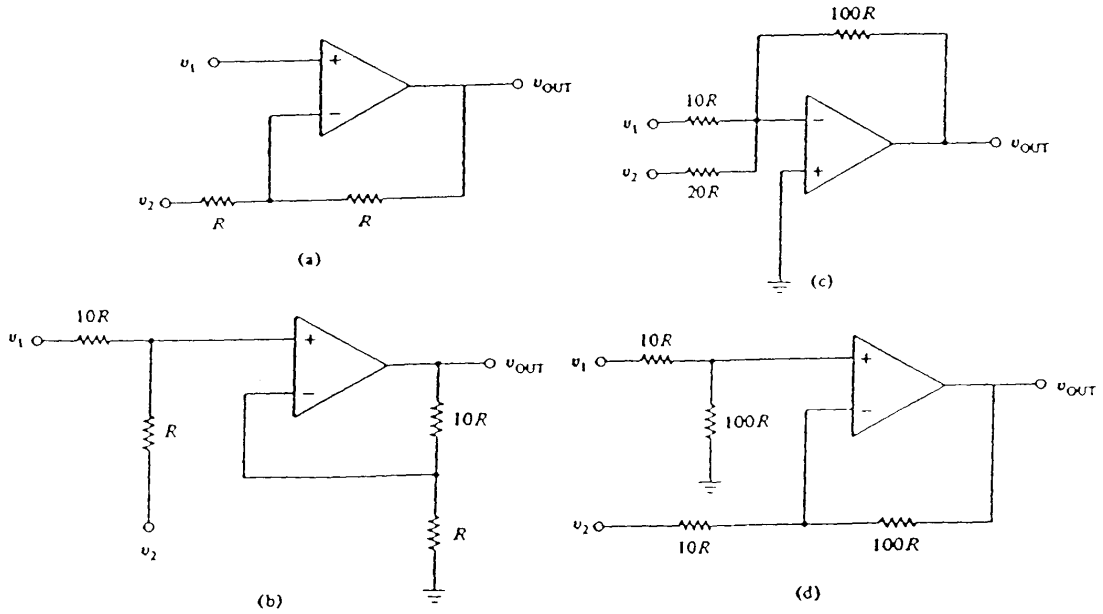

Fig T.1-1

2. Consider an op-amp follower (i.e. the output is connected to the negative input) powered by ±l5V supplies. The input voltage is set to 1V and the output feeds a 100 Ω resistive load R_L to ground. 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. (Note: V_{CC} is the positive supply voltage of +15V and V_{EE} is the negative supply voltage of -15V).

a) Draw a diagram of this circuit. Label the current I_P and I_N.
b) What is the difference between the power supply currents I_P and I_N when R_L is connected?
c) 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 ±l5V 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 1 V 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 Tl-2. Assume the op-amp used is ideal.

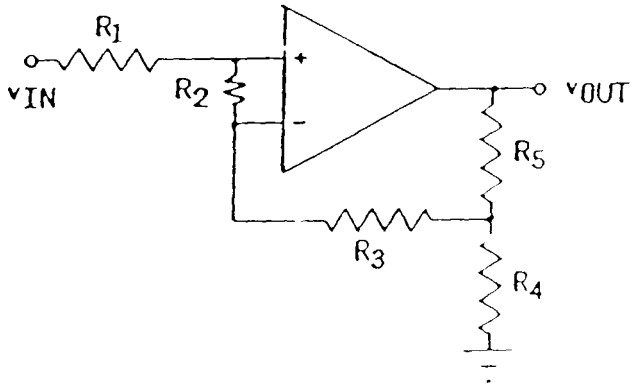

Fig. T 1-2

5. An inverting amplifier with a gain of -10 is made from a non-ideal op-amp having an input offset voltage of lmV. A sinusoidal input voltage of 0.1mV peak amplitude is applied. What are the resulting ac and dc components of the output voltage?

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) $I_P - I_N = 10$ mA
(c) The additional power drawn from V_{CC} is
$\triangle P = 150$ mW
No additional power is drawn from V_{EE}, the negative supply.
3. The maximum permissible gain of the second stage is 28.

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

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