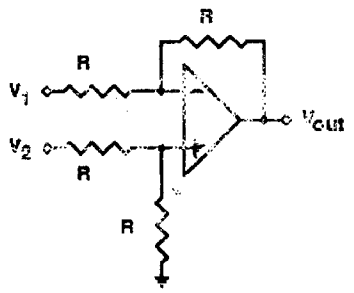
ELECTRONISC I * Midterm 1 * 60 minutes * closed books and notes

I have neither given nor received unauthorized help with this exam, nor do I have reason that anybody else has

ID no : _____ *Name:* _____ *Signature:* _____

1) For the circuit given below, express v_{out} as a function of v_1 and v_2. What is the input resistance seen by v_1 alone (i.e., the other source is zero)? By v_2 alone? By a source connected between two input terminals? By a source connected to both input terminals simultaneously?

q=24



Use superposition

$v_{out} = v_2 - v_1$

$r_{in1} = R$

$r_{in2} = 2R$

$r_{indiff} = 2R$

$r_{incm} = R$

$V_1 = 0 \rightarrow V_{out} = \left(\frac{R+R}{R}\right) V_+$ (noninv. amp)

$V_+ = V_2 \frac{R}{R+R}$

$V_0 = V_2$

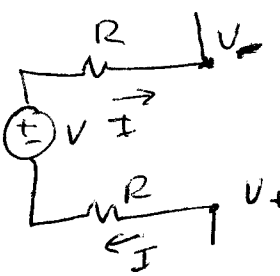
$V_2 = 0 \rightarrow$ noninverting amp $V_{out} = -\frac{R}{R} V_1 = -V_1$

Superposition $V_{out} = V_2 - V_1$

$r_{in1} = \frac{V_1 - 0}{I_1} = \frac{V_1}{\frac{V_1}{R}} = R$

$r_{in2} = R + R = 2R$

$r_{indiff} = \frac{V}{I}$ where



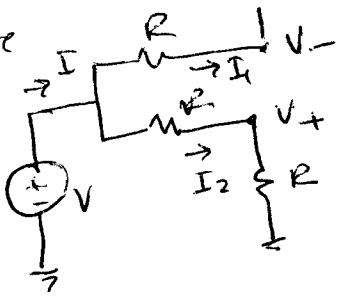
$V_- = V_+$ (neg. f.b.)

$V_+ IR - V + IR = V_+$

$2IR = V$

$2R = \frac{V}{I}$

$r_{incm} = \frac{V}{I}$ where



$V_+ = V_-$

$V_+ = \frac{V}{2}$

$I = I_1 + I_2$

$I_1 = I_2 = \frac{V - \frac{V}{2}}{R} = \frac{V}{2R}$

$I = 2\frac{V}{2R} = \frac{V}{R}$

hence $\frac{V}{I} = R$

q=30

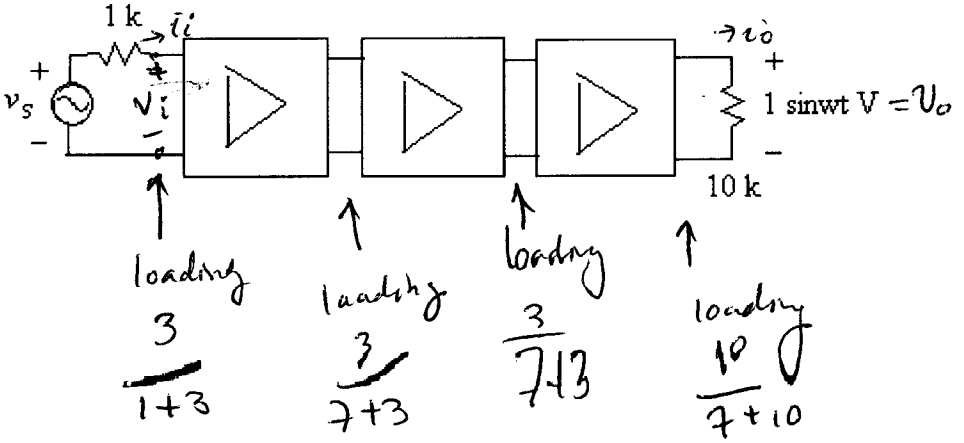
2) The amplifiers used in the circuit are identical with r_{in} = 3 kΩ, r_{out} = 7 kΩ, open-circuit voltage gain = – 80 v/v, and each amplifiers draw 100 mA from a 9V power supply regardless of the signal amplitude.

a) Find the overall voltage gain — v_o/v_s = -20329

b) Find the overall power gain — p_o/p_i = 220411482

c) Find the overall current gain — i_o/i_s = -8131

d) Find the efficiency of the amplifier circuit — η = 1.85×10^{-3} %



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$$\frac{v_o}{v_i} = (-80)(-80)(-80)\,\frac{3}{10}\,\frac{3}{10}\,\frac{10}{17} = -27.105$$

$$\frac{v_o}{v_s} = \frac{v_o}{v_i} \cdot \frac{3}{1+3} = -20.329$$

$$A_i = \frac{i_o}{i_s} = \frac{v_o/10k}{v_s/(1+3)k} = -20.329\,\frac{4}{10} = -8.131$$

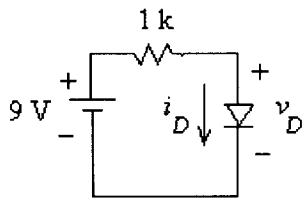
$$\frac{p_o}{p_i} = \frac{v_o \cdot i_o}{v_i \cdot i_i} = (-27.105) \times (-8.131) = 220.411462$$

$$\text{efficiency} = \eta = \frac{P_o}{P_{DC}} = \frac{\left(\frac{1}{\sqrt{2}}\right)^2 \frac{1}{10k}}{3 \times 100 \times 9} = \frac{0.05\ mW}{2700\ mW}$$

$$= 1.85 \times 10^{-5}$$

$$= 1.85 \times 10^{-3}\ \%$$

3) Use the non-linear diode model to find the voltage and current of the diode in the circuit below. (I_s = 1 nA, V_T = 0.025 V, η= 1) Calculate the voltage with an accuracy of 1 mV; current, 1 μA. v_D = 0.3992 V i_D = 8.6008 mA



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$\eta = 1$, $I_S = 10^{-9}$ A

$$I_D = I_S\left(e^{v_D/\eta V_T} - 1\right)$$

$$v_D = \eta V_T \ln\left(\frac{I_D}{I_S} + 1\right)$$

$$v_D + i_D\,1k = 9$$

$$i_D = \frac{9 - v_D}{1k}$$

initial guess: $v_{D_0} = 0 \rightarrow i_{D_0} = 9\text{ mA} = 9000\ \mu\text{A}$

$$v_{D_1} = 0.025 \ln\left(\frac{9\times10^{-3}}{10^{-9}} + 1\right) = 0.4003\text{ V}$$

$$i_{D_1} = \frac{9 - 0.4003}{1k} = 8.5997\text{ mA}$$

$$v_{D_2} = 0.025 \ln\left(\frac{8.5997\times10^{-3}}{10^{-9}} + 1\right) = 0.3992\text{ V}$$

$$i_{D_2} = \frac{9 - 0.3992}{1k} = 8.6008\text{ mA}$$

$$v_{D_3} = 0.025 \ln\left(\frac{8.6008\times10^{-3}}{10^{-9}} + 1\right) = 0.3992\text{ V}$$

$$i_{D_3} = \frac{9 - 0.3992}{1k} = 8.6008\text{ mA}$$

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