Q1. Answer the following: each carry 2 marks. (10 Marks)

(a) Draw the o/p waveform, assume ideal conditions.

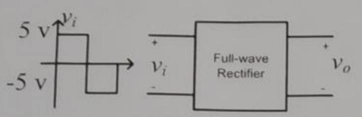


Fig. 1.1

Ans:

(b) Assume $r_z = 0$, determine I_z and also the power dissipated in Zener.

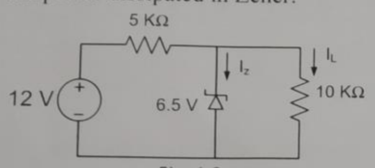


Fig. 1.2

Ans:

$I_z = 0.45\ mA$

$P_z = 0.45 \times 6.5 = 2.9\ mW$

(c) If v_i is having 10 V peak amplitude, determine the current gain (i_o/i_i)

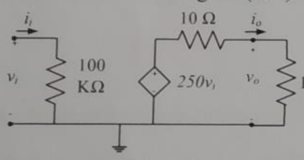


Fig. 1.3

Ans:

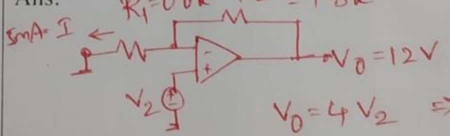
$i_1 = \frac{10}{100K} = 0.1\ mA$

$i_0 = \frac{2500}{1010} = 2.475\ A$

$\frac{i_0}{i_1} = 24.75\ K\ (A/A)$

(d) Design a noninverting amplifier with $|A|=4$ (v/v). At the maximum output voltage of 12 V the current in the voltage divider is 5 mA.

Ans: $R_1 = 0.6K$ $R_2 = 1.8K$

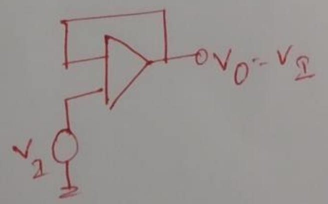


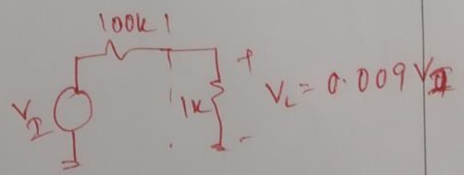
$V_0 = 4V_2 \Rightarrow V_2 = 3V$

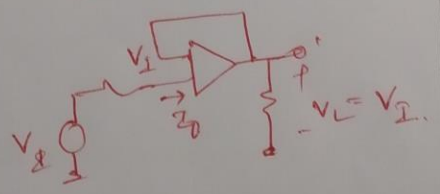
$R_2 = 3R_1$ $R_1 = \frac{3}{5} = 0.6K\Omega$ $R_2 = \frac{9}{5} = 1.8K\Omega$

(e) Draw the voltage follower circuit, explain how it acts as an impedance transformer.

Ans:







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Q2. Analyse the circuit to determine, V_C, V_B, V_E, I_C, I_B, and I_E. Assume that $V_{BE} = 0.6$ V, and $\beta = 49$. Also comment on the mode of operation. (6 Marks)

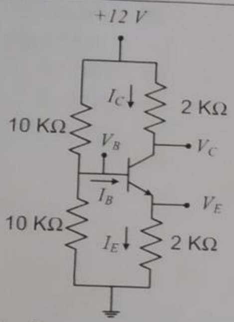
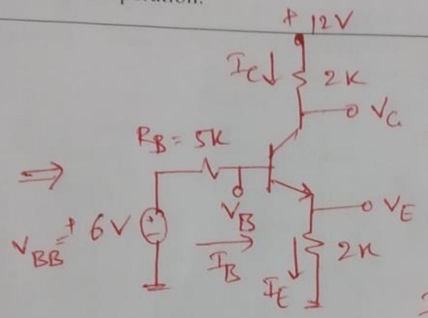


Fig. 2.

$\Rightarrow$



$$I_B = \frac{V_{BB} - V_{BE}}{R_B + (\beta+1) R_E}$$

$$I_B = \frac{5.4}{5k + 50 \times 2k} = 51.4 \mu A$$

$I_E = (\beta+1) I_B$

$I_C = \beta I_B$

$\boxed{I_C = 2.52 mA}$

$\boxed{I_E = 2.57 mA}$

$\boxed{I_B = 0.051 mA}$

$51.4 \mu A$.

$I_E > I_C > I_B$

$V_B = V_{BE} + I_E R_E$

$= 0.6 + 2.57 \times 2$

$\boxed{V_B = 5.74 V}$

$\boxed{V_E = I_E R_E = 5.14 V}$

$V_C = V_{CC} - I_C R_C = 12 - 2.52 \times 2$

$\boxed{V_C = 6.96 V}$

$\boxed{V_E < V_B < V_C}$

Rough work:

Active mode

Q3. Two amplifiers are connected in cascade between a 10 mV source with resistance 100 kΩ and a 1 kΩ load, shown in Fig. 3. First amplifier is having open circuit voltage gain, input resistance, and output resistance as 100 (V/V), 100 kΩ, and 1 kΩ, and the second amplifier is having short circuit transconductance, input resistance and output resistance as 60 mA/V, 5 kΩ, and 15 kΩ respectively. Determine i_o/v_s. (4 Marks)

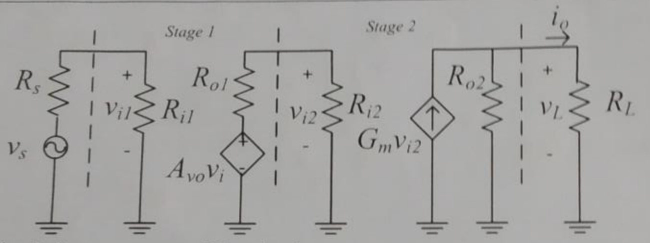


Fig. 3. Two-stage amplifier circuit.

$v_{i_1} = 5\,mV$

$$v_{i_1} = \frac{V_s \times R_{i_1}}{R_s + R_{i_1}} \Rightarrow \frac{v_{i_1}}{v_s} = \frac{R_{i_1}}{R_{i_1}+R_s} = 0.5 \text{ (V/V)}$$

$v_{i_2} = 416.5\,mV$

$$\frac{v_{i2}}{v_{i1}} = \frac{A_{vo} R_{i2}}{R_{i2}+R_{o1}} = \frac{100 \times 5k}{5k+1k} = 83.3 \text{ (V/V)}$$

$i_o = 2.343\,mA$

$$\frac{i_o}{v_{i2}} = \frac{G_m R_{o2}}{R_{o2}+R_L} = \frac{60\times10^{-3} \times 15k}{15k+1k} = 56.25m \text{ (A/V)}$$

$$\frac{i_o}{v_s} = \frac{i_o}{v_{i2}} \times \frac{v_{i2}}{v_{i1}} \times \frac{v_{i1}}{v_s} = 2.34 \text{ (A/V)}$$

Rough work:

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Q4. For the Op-amp circuit shown in fig. 4, determine v_o for, (a) $R_1 = R_2 = R_3 = R_4 = R$, and for (b) $R_1 = R_2/2 = R_3/4 = R_4/6 = R$ (4 Marks)

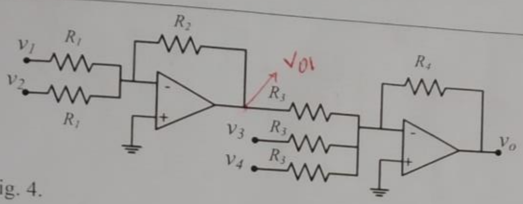


Fig. 4.

(a) $R_1 = R_2 = R_3 = R_4 = R.$

$$V_{01} = -(V_1 + V_2) \;;$$

$$V_0 = -(V_3 + V_4) + V_1 + V_2 = V_1 + V_2 - V_3 - V_4$$

(b) $R_1 = R$; $R_2 = 2R$; $R_3 = 4R$; $R_4 = 6R$

$$\frac{R_4}{R_3} = \frac{6}{4} = \frac{3}{2}$$

$$\frac{R_2}{R_1} = 2$$

$$V_0 = \frac{3}{\cancel{2}} \times \cancel{2}(V_1 + V_2) - \frac{3}{2}(V_3 + V_4)$$

$$V_0 = 3V_1 + 3V_2 - 1.5V_3 - 1.5V_4$$

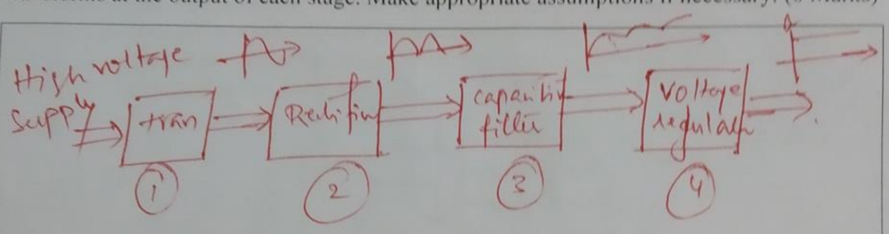
Rough Work:

$$V_{01} = -\frac{R_2}{R_1}V_1 - \frac{R_2}{R_1}V_2 = -\frac{R_2}{R_1}(V_1 + V_2)$$

$$V_0 = -\frac{R_4}{R_3}(V_{01} + V_3 + V_4) = \left(\frac{R_4}{R_3}\right)\left(\frac{R_2}{R_1}\right)(V_1 + V_2) - \frac{R_4}{R_3}(V_3 + V_4)$$

$$V_0 = \left(\frac{R_4}{R_3}\right)\left(\frac{R_2}{R_1}\right)(V_1 + V_2) - \frac{R_4}{R_3}(V_3 + V_4)$$

Q5. Draw the block diagram of a DC power supply, explain its operation, and also draw the waveforms at the output of each stage. Make appropriate assumptions if necessary. (6 Marks)



(1) ⇒ (a) provides electrical isolation

(b) The high voltage AC is down converted to specific value

(2) converts bipolar AC signal to unipolar

(3) filter the time dependency of the unipolar signal.

(4) Reduces the ripple due to filter operation and Stabilize the magnitude of the dc o/p voltage.