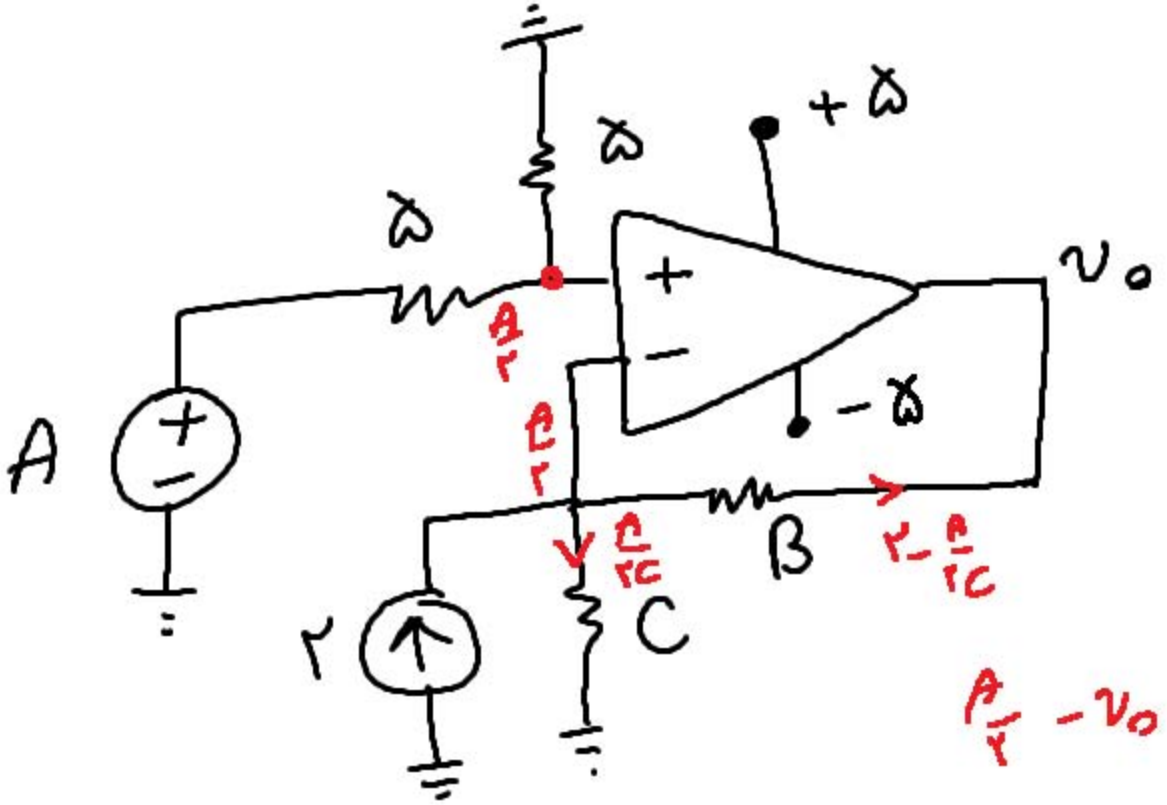
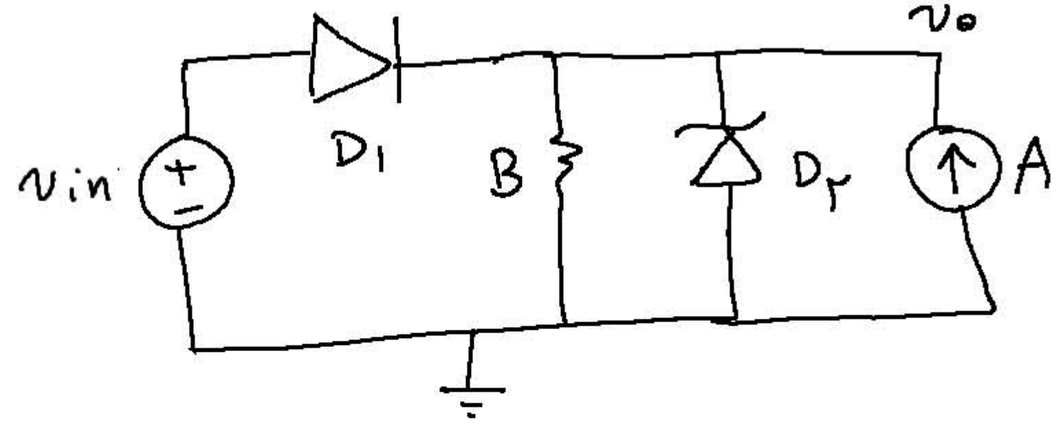


$$\frac{A}{2} - v_o = B\left(2 - \frac{A}{2C}\right)$$

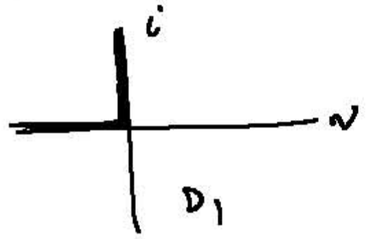
$$\longrightarrow v_o = \frac{A}{2} - 2B + \frac{AB}{2C}$$

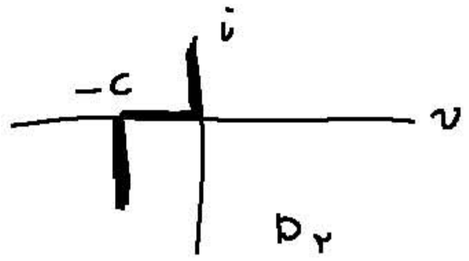
$$-A < \qquad\qquad < A$$



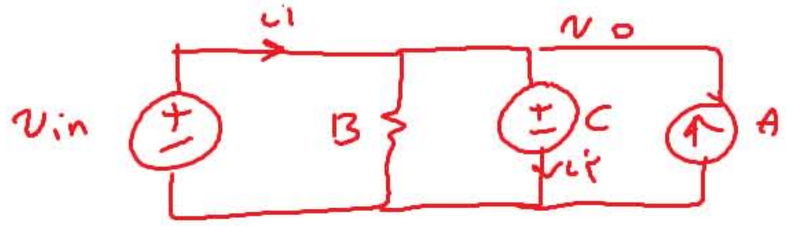
D_1: دیود حرارتی ، مدل ایده‌آل ($R_D=0$, $V_{th}=0$)

D_2: دیود زنر ، مدل ایده‌آل ($R_D=0$, $V_{th+}=0$, $V_{th-}=-C$)





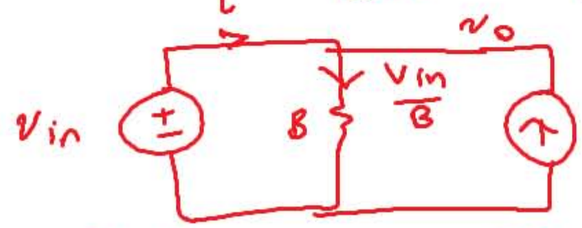
۱) D_1 روشن ، D_2 روشن معکوس



$i_1 , i_2 > 0$

$v_o = C = v_{in}$

۲) D_1 روشن ، D_2 خاموش

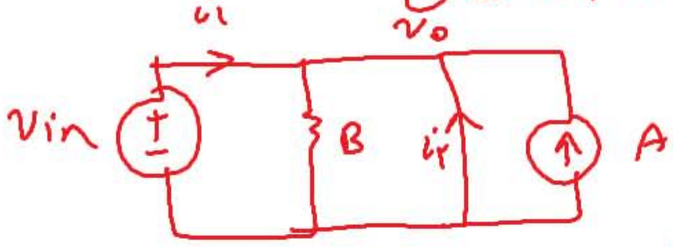


$\frac{v_{in}}{B} - A > 0$

$\rightarrow v_{in} > AB$

$AB < v_o = v_{in} < C$ (only if $C \geq AB$)

۳) D_1 روشن ، D_2 روشن

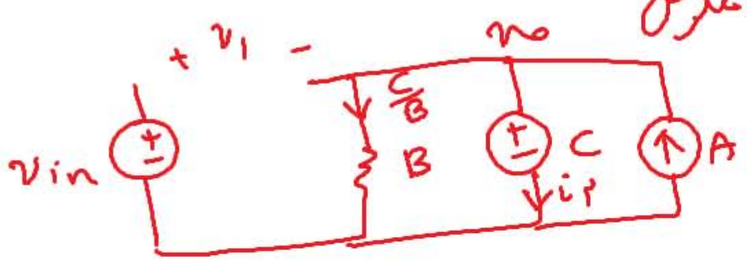


$i_1 , i_{r2} > 0$

$i_1 + i_{r2} + A = 0$

※ با فرض مثبت بودن A تناقض دارد.

۴) D_1 خاموش ، D_2 روشن معکوس



$i_{r2} > 0$

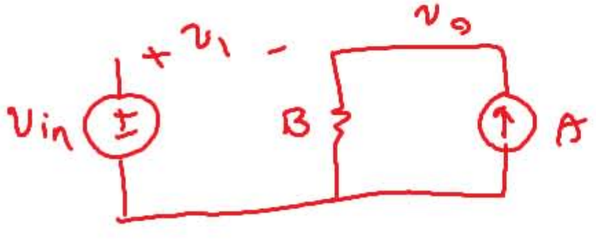
$v_1 < 0$

$v_o = C$

$i_{r2} = A - \frac{C}{B} > 0 \rightarrow A > \frac{C}{B} \rightarrow AB > C$

$v_{in} < C$

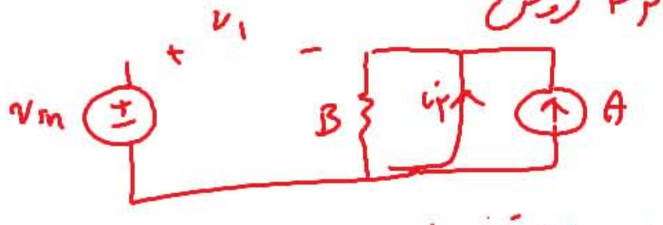
۵) D_1 خاموش ، D_2 خاموش



$0 < v_o = AB < C$

$v_{in} < AB$

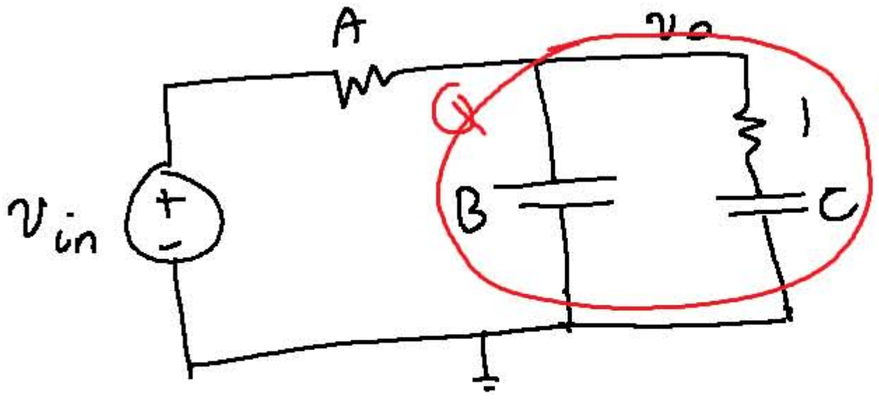
۶) D_1 خاموش ، D_2 روشن



$v_o = 0$

$i_{r2} = -A > 0$

※ با فرض مثبت بودن A تناقض دارد.



$$H(jw) = \frac{v_o}{v_{in}} = \frac{Q}{Q+A}$$

$$Q = \frac{\frac{1}{Bjw} \times (1 + \frac{1}{cjw})}{\frac{1}{Bjw} + 1 + \frac{1}{cjw}} = \frac{1 + \frac{1}{cjw}}{1 + Bjw + \frac{B}{c}}$$

$$\rightarrow Q = \frac{cjw + 1}{cjw + Bjw - BCw^2}$$

$$\rightarrow H = \frac{cjw + 1}{cjw + 1 + A(B+c)jw - ABCw^2}$$

$$= \frac{cjw + 1}{1 - ABCw^2 + (AB+AC+c)jw}$$

$w = 0 \quad H \rightarrow 1$

$w = \infty \quad H \rightarrow 0$

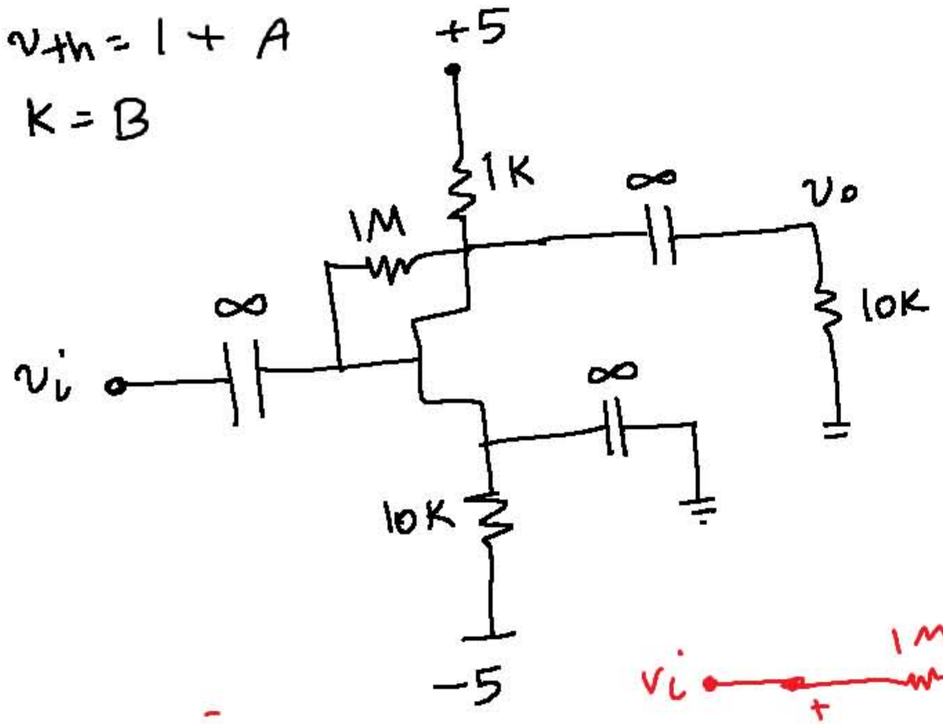
پایین گذر

$$|H(jw_c)|^2 = \frac{1}{2} \rightarrow \frac{1 + c^2 w_c^2}{(1 - ABCw_c^2)^2 + (AB+AC+c)^2 w_c^2} = \frac{1}{2}$$

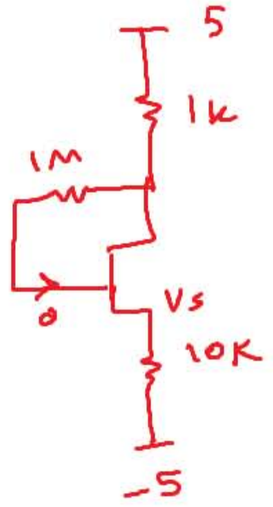
فرکانس قطع

$v_{th} = 1 + A$

$K = B$



تحلیل dc



الف) $V_G = V_D \longrightarrow$ اشباع

$10K\, I - 5 = V_s$

$5 - 1K\, I = V_G$

$\longrightarrow V_{GS} = 10 - 11K\, I$

$I = \frac{B}{2}\left(10 - 11K\, I - A - 1\right)^2$

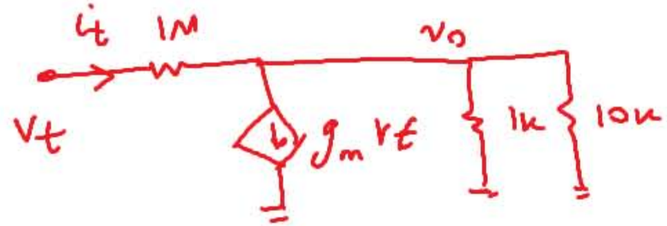
$\longrightarrow I = \dots$

ب) KCL: $\frac{v_o}{1K} + \frac{v_o}{10K} + 1m\, v_i + \frac{v_o - v_i}{1M} = 0$

$\longrightarrow \frac{v_o}{v_i} = \frac{1\mu - 1m}{1m + 0.1m + 1\mu} \simeq \frac{-1}{1.1} = -0.91$

تحلیل ac و محاسبه بهره

مقاومت ورودی

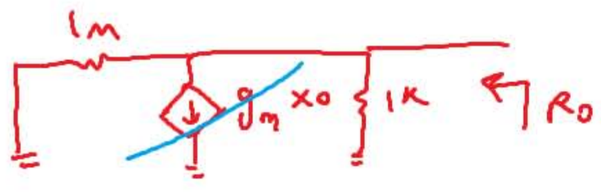


ت) $v_t = 1M\, i_t + (i_t - 1m\, v_t)\underbrace{(10k \parallel 1k)}_{0.91k}$

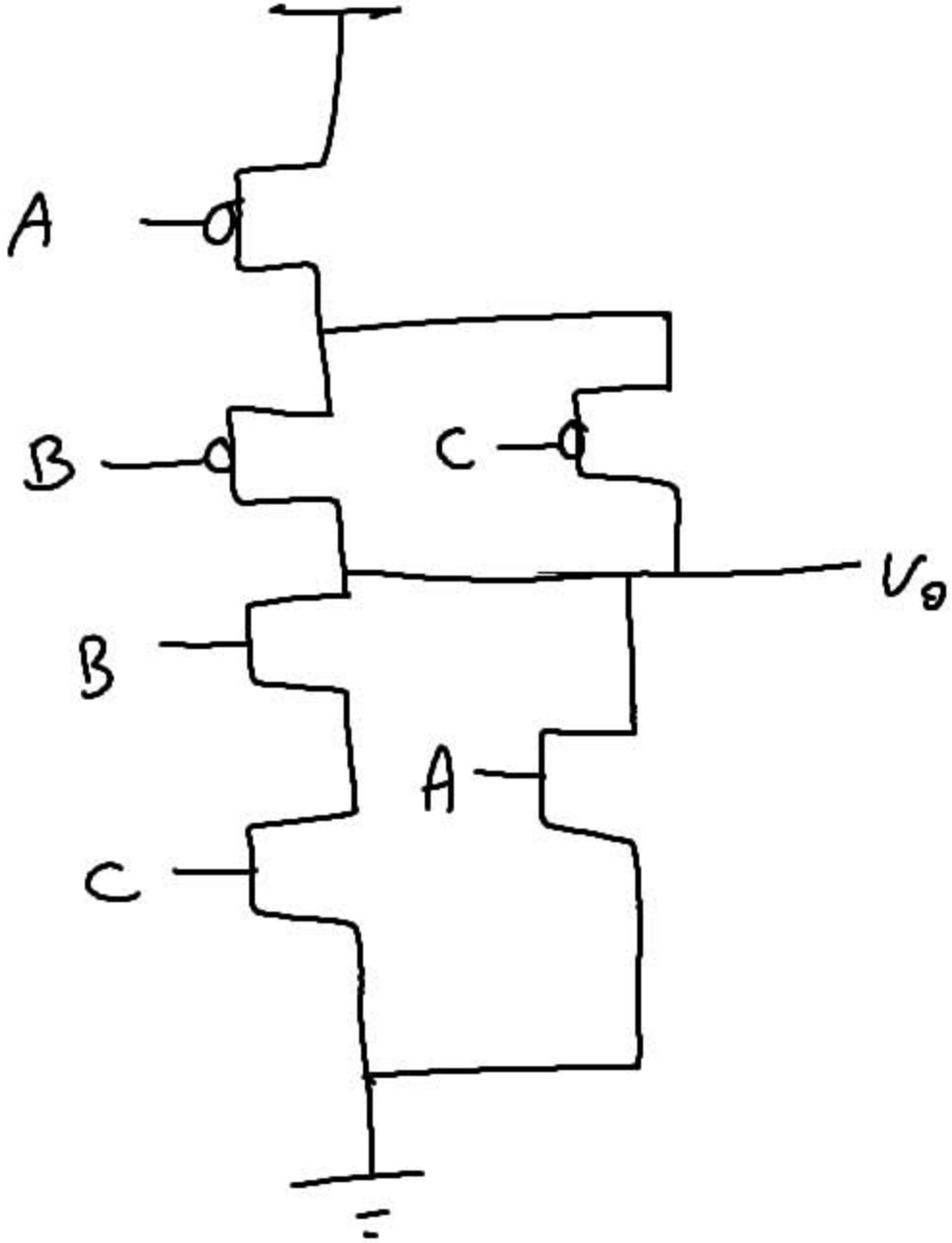
$= (1M + 0.91k)\, i_t - 0.91\, v_t$

$\longrightarrow R_{in} = \frac{v_t}{i_t} = \frac{1M + 0.91k}{1.91} \simeq 524\, k\Omega$

مقاومت خروجی



$R_o = 1k \parallel 1M = 999\, \Omega$



A	B	C	V_0
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

٨ حالات