# 전자회로 1차 과제

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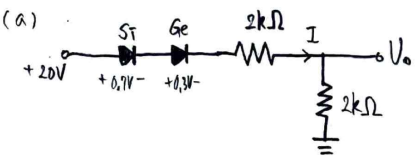
|---|---|
| 과목명 | 전자회로[A] |
| 학번 | 23T1022 |
| 이름 | 이학민 |
| 제출일 | 2023.10.17. |

1. 다음 회로에서 출력 $V_o$를 구하라. (단, Si는 0.7V, Ge는 0.3V 에서 켜짐)

(a)




두 다이오드는 도통되므로 각각 0.7V, 0.3V 의 전압을 갖는다.

$\therefore\ 20 - 0.7 - 0.3 - 2kI - 2kI = 0$ (KVL)

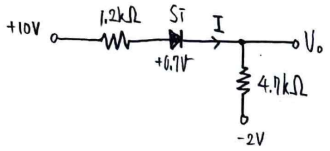
$4kI = 19$

$I = 4.75\ [mA]$

$V_o = 2kI = 2k \times 4.75m = 9.5\ [V]$

$\boxed{V_o = 9.5\ [V]}$

(b)




다이오드는 도통되므로 0.7V의 전압을 갖는다.

$10 - 1.2kI - 0.7 - 4.7kI = -2$ (KVL)

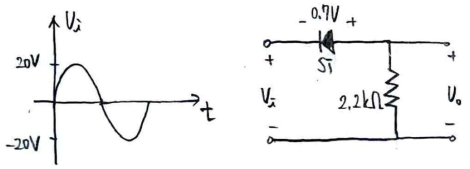
$5.9kI = 11.3$

$I = 1.915\ [mA]$

$V_o = -2 + 4.7k \times 1.915m = 7.001\ [V]$

$\boxed{V_o = 7.001\ [V]}$

2. 다음회로에서 입력 $V_i$가 그림과 같을 때, 출력 $V_o$를 $V_i$의 함수식으로 나타내라.

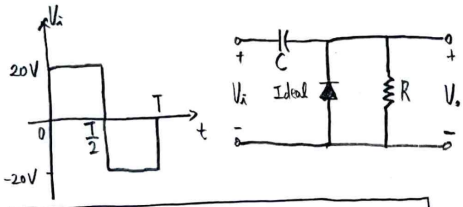


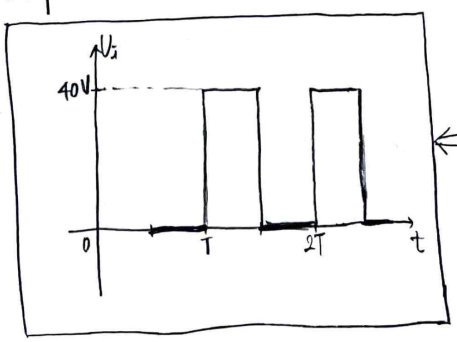

$V_i < -0.7V$ 일때 다이오드가 도통된다. 도통시 다이오드는 0.7V의 전압을 가지므로 $V_o$는 다음과 같다.

$\therefore$ $\boxed{V_i < -0.7 : V_o = V_i + 0.7\ [V]}$

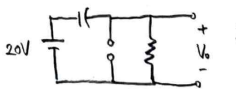
$\boxed{V_i > -0.7 : V_o = 0\ [V]}$

3. 다음 회로에서 입력 $V_i$가 그림과 같을 때, 출력 $V_o$를 시간축의 좌표평면에 그려라



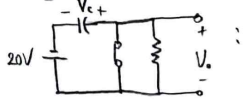




(1) $0 \le t < \frac{T}{2}$




: Reverse bias

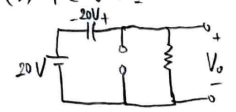
(2) $\frac{T}{2} \le t < T$




: $V_o = 0$

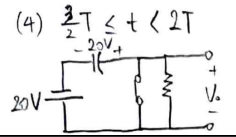
$-20 + V_c = 0$ $\therefore V_c = 20\ [V]$ 로 충전됨

(3) $T \le t < \frac{3}{2}T$



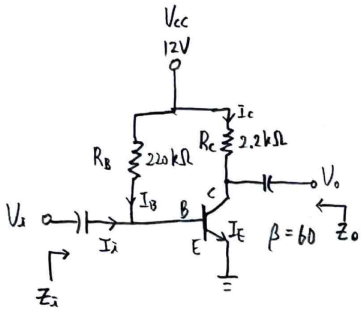

: $V_o = V_i + V_c = 20 + 20 = 40\ [V]$

(4) $\frac{3}{2}T \le t < 2T$




: $V_o = V_i + V_c = -20 + 20 = 0\ [V]$

4. 다음 고정 바이어스 회로에서 DC 분석을 통해서 $g_m$을 구하고, 소신호 분석을 통해서 $Z_i$, $Z_o$, $A_v$를 구하라. (단, $r_o$는 무시하라.)




① DC 분석

B-E loop : $V_{cc} - R_B I_B - V_{BE} = 0$

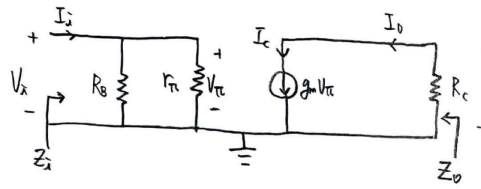
$$I_B = \frac{V_{cc} - V_{BE}}{R_B} = \frac{12 - 0.7}{220k} = 0.051\ [mA]$$

$$I_C = \beta I_B = 60 \times 0.051m = 3.06\ [mA]$$

$$g_m = \frac{I_C}{V_T} = \frac{3.06m}{26m} = 0.1177\ [S]$$

$$r_\pi = \frac{\beta}{g_m} = \frac{60}{0.1177} = 509.7706\ [\Omega]$$

② 소신호 분석



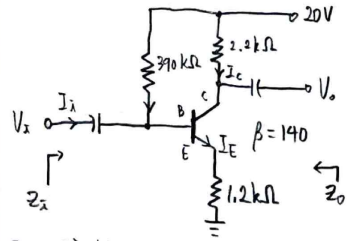

(1) $Z_i = R_B // r_\pi = \frac{220k \times 509.7706}{220k + 509.7706} = 508.5921\ [\Omega]$

(2) $Z_o = R_c = 2.2\ [k\Omega]$

(3) $A_V = \frac{V_o}{V_i} = \frac{-I_o R_c}{V_\pi} = \frac{-g_m V_\pi R_c}{V_\pi} = -g_m R_c = 0.1177 \times 2.2k$

$= 258.94 \approx 259$

5. 다음 이미터 안정화 바이어스 회로에서 DC 분석을 통해서 $g_m$을 구하고, 소신호 분석을 통해서 $Z_i$, $Z_o$, $A_v$를 구하라. (단, $r_o$는 무시하라)




① DC 분석

B-E loop : $20 - 390k I_B - V_{BE} - 1.2k I_E = 0$

$I_E = (\beta+1) I_B$

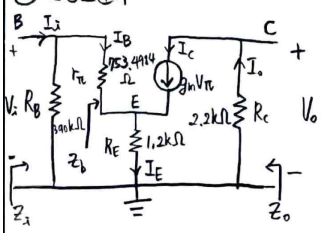
$20 = I_B \times 390k + 0.7 + 141 \times 1.2k \times I_B$

$$I_B = \frac{20 - 0.7}{390k + 141 \times 1.2k} = 0.0345\ [mA]$$

$I_C = \beta I_B = 140 \times 0.0345m = 4.83\ [mA]$

$$g_m = \frac{I_C}{V_T} = \frac{4.83m}{26m} = 0.1858\ [S] \qquad r_\pi = \frac{\beta}{g_m} = \frac{140}{0.1858} = 753.4984\ [\Omega]$$

② 소신호 분석



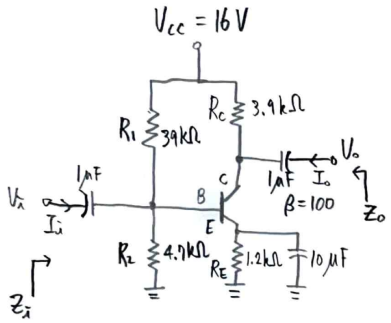

(1) $Z_i = R_B // Z_b = \frac{390k \times 169.953k}{390k + 169.953k} = 118.3701\ [\Omega]$

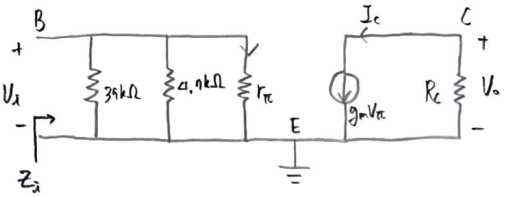
($\because Z_b = r_\pi + (\beta+1) R_E = 753.4984 + 141 \times 1.2k = 169.953\ [k\Omega]$)

(2) $Z_o = R_C = 2.2\ [k\Omega]$

(3) $A_v = \frac{V_o}{V_i} = -\frac{g_m R_c}{1 + g_m R_E} = -\frac{0.1858 \times 2.2k}{1 + 0.1858 \times 1.2k} = -1.825$

6. 다음 전압 배분기 바이어스 회로에서 DC 분석을 통해서 $g_m$을 구하고, 소신호 분석을 통해서 $Z_i$, $Z_o$, $A_V$를 구하라. (단, $r_o$는 무시하라.)




① DC 분석

$$V_B = \frac{R_2}{R_1+R_2} \times V_{CC} = \frac{4.7k}{39k+4.7k} \times 16 = 1.721\ [V]$$

$$R_B = R_1 /\!/ R_2 = \frac{39k \times 4.7k}{39k+4.7k} = 4.19\ [k\Omega]$$

$$I_B = \frac{V_B - V_{BE}}{R_B + (\beta+1)R_E} = \frac{1.721 - 0.7}{4.19k + 101 \times 1.2k} = 0.0081\ [mA]$$

$$I_C = \beta I_B = 100 \times 0.0081m = 0.81\ [mA]$$

$$g_m = \frac{I_C}{V_T} = \frac{0.81m}{26m} = 0.031\ [S] \qquad r_\pi = \frac{\beta}{g_m} = 3.226\ [k\Omega]$$

② 소신호 분석

(1) $Z_i = 39k /\!/ 4.7k /\!/ 3.226k = 4.195k /\!/ 3.226k = 1.824\ [k\Omega]$

(2) $Z_o = R_c = 3.9\ [k\Omega]$

(3) $A_V = \frac{V_o}{V_i} = -g_m R_c = -0.031 \times 3.9k = -120.9 \approx -121$