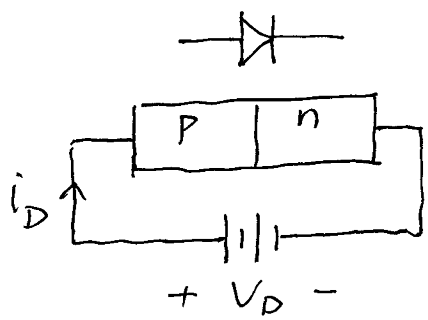
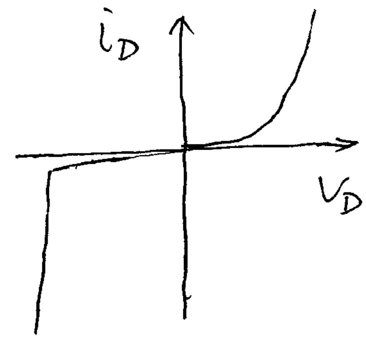
CMPE 314 Midterm Exam-1 Solutions

Summer 2018

P1





$i_D = I_s (e^{V_D/V_T} - 1)$ in both forward and reverse bias.

$V_Z = V_{Z0} + r_Z I_Z$ in reverse break down

$V_Z = - V_D, \; I_Z = -I_D$

Crrents in

forward bias h^+ moving from p-region to n-region

e^- moving from n-region to p-region

reverse bias e^- moving from p-region to n-region

h^+ moving from n-region to p-region

reverse break down

h^+ moving from space-charge region to p-region

e^- moving from space-charge region to n-region

P2

$$V_{D1} = V_{\gamma 1} + r_{f1} I_{D1}$$

$$V_{D2} = V_{\gamma 2} + r_{f2} I_{D2}$$

$$V_{D1} = V_{D2} + R I_{D2}$$

$$I_S = I_{D1} + I_{D2}$$

$$\rightarrow \quad V_{\gamma 1} + r_{f1} I_{D1} = V_{\gamma 2} + (r_{f2} + R)(I_S - I_{D1})$$

$$\rightarrow \quad I_{D1} = \frac{(V_{\gamma 2} - V_{\gamma 1}) + (r_{f2} + R) I_S}{r_{f1} + r_{f2} + R}$$

$$I_{D2} = I_S - I_{D1} = \frac{-(V_{\gamma 2} - V_{\gamma 1}) + r_{f1} I_S}{r_{f1} + r_{f2} + R}$$

P3

(a) $V_i > 0$, D_2 on, D_1 off

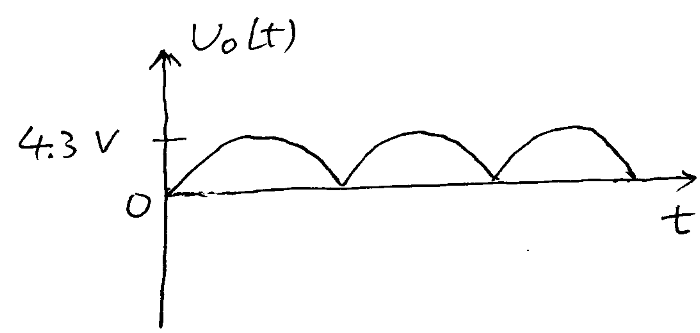
$$V_o = V_i \frac{R_L // R_2}{R_1 + R_L // R_2}$$

$V_i < 0$, D_1 on, D_2 off

$$V_o = -V_i \frac{R_L // R_1}{R_2 + R_L // R_1}$$

(b) $$V_o(max) = 10 \frac{6.8 // 2.2}{2.2 + 6.8 // 2.2} = 10 \frac{\frac{14.96}{9}}{2.2 + \frac{14.96}{9}} = 4.3 \text{ V}$$

$V_o(min) = 0$



P4

(a) • $v_D = V_B - v_I$ near threshold

$V_B - v_I > V_\gamma$ or $v_I < V_B - V_\gamma$, diode on

$v_O(t) = v_I(t) + V_\gamma$

• $V_B - v_I < V_\gamma$ or $v_I > V_B - V_\gamma$, diode off

$v_O = V_B$

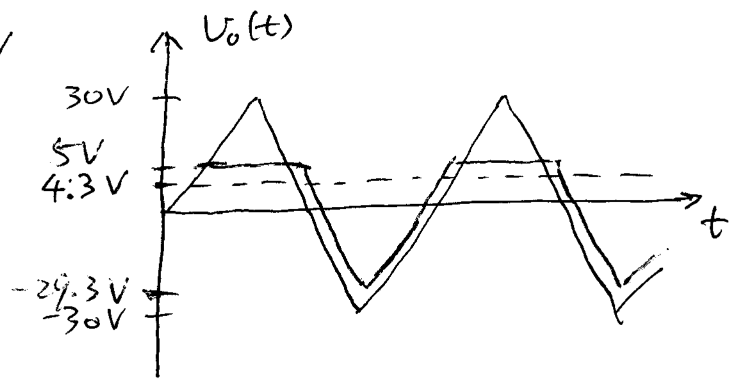
(b) $v_I < 5 - 0.7 = 4.3\text{ V}$

$v_o(t) = v_I(t) + 0.7\text{ V}$

$v_o(\min) = -30 + 0.7\text{ V} = -29.3\text{ V}$

$v_I > 4.3\text{ V}$

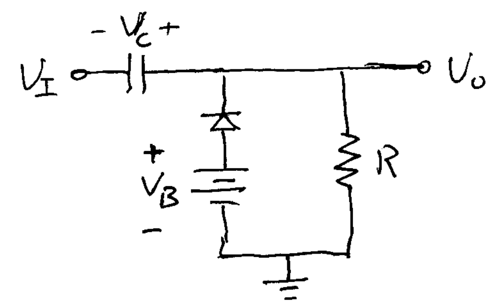
$v_o(t) = 5\text{ V}$



A clipper circuit.

P5

(a) Let $v_c(0) = 0$



$v_D = V_B - v_I$

- When $V_B - v_I > V_\gamma$

or $v_I < V_B - V_\gamma$, diode on, capacitor charging.

$v_c(t) = V_B - V_\gamma - v_I(t)$

$v_c(\text{peak}) = V_B - V_\gamma - v_I(\text{min})$

- When $v_I(t) > v_I(\text{min})$, diode off, capacitor discharging very slowly.

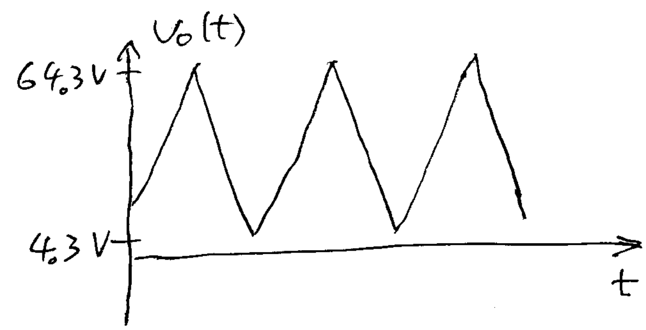
$v_c \doteq v_c(\text{peak})$

- In the steady state

$v_o(t) = v_I(t) + v_c(\text{peak})$

(b) $v_c(\text{peak}) = 5 - 0.7 - (-30) = 34.3\text{ V}$

$V_o(t) = v_I(t) + 34.3\text{ V}$



It is a clamper circuit.

P6

$V_I > V_{Z0}$, diode is in reverse break down.

$$V_Z = V_{Z0} + r_Z I_Z$$

$$P_Z = V_Z I_Z = (V_{Z0} + r_Z I_Z) I_Z$$

$$= (5 + 10 I_Z) I_Z < 0.4\ W$$

$$\rightarrow \quad I_Z < 0.03855\ A$$

$$V_Z = V_{Z0} + r_Z I_Z < 10.3855\ V$$

$$I_I = \frac{V_I - V_Z}{R_i} > \frac{20 - 10.3855}{200} = 0.04807\ A$$

$$I_L = I_I - I_Z > 0.04807 - 0.03855 = 0.0095\ A$$

$$\rightarrow \quad R_L = \frac{V_L}{I_L} = \frac{V_Z}{I_L} < \frac{10.3855\ V}{0.0095\ A} = 1093\ \Omega$$