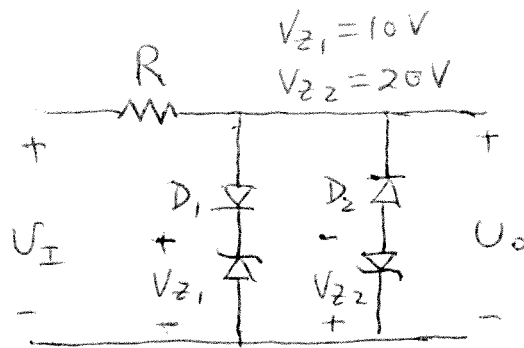


P3

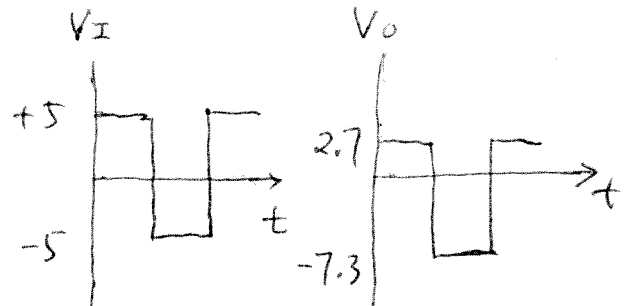
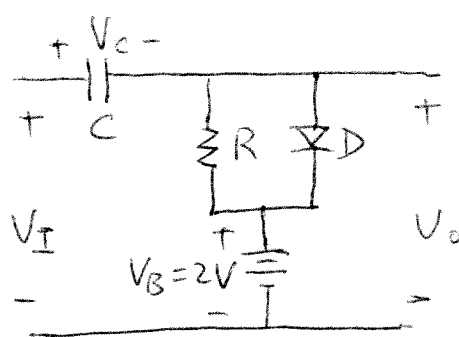


$$U_I > V_{Z1} + V_f, D_1 \text{ on } D_2 \text{ off} \quad U_O = V_{Z1} + V_f = 10.7 \text{ V}$$

$$U_I < -(V_{Z2} + V_f), D_1 \text{ off } D_2 \text{ on} \quad U_O = -(V_{Z2} + V_f) = -20.7 \text{ V}$$

$$-(V_{Z2} + V_f) < U_I < V_{Z1} + V_f \quad D_1 \text{ off } D_2 \text{ off} \quad U_O = U_I$$

P4



Let capacitor initially discharged $U_C(0) = 0$

When $U_I > V_B + V_f$ diode is on, capacitor is charging

$$U_C = U_I - (V_B + V_f)$$

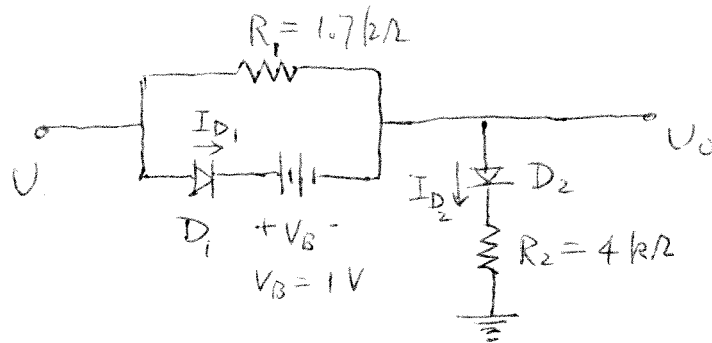
$$U_{C, \max} = U_{I, \max} - (V_B + V_f) = 5 - 2.7 = 2.3 \text{ V}$$

When $U_I < U_{I, \max}$, diode is off. Capacitor discharges very slowly.

$$U_C \approx U_{C, \max}$$

$$U_O = U_I - U_{C, \max} = U_I - 2.3 \text{ V}$$

P5



If both D_1 and D_2 are on

$$V_O = V_I - V_f - V_B = 5 - 0.7 - 1 = 3.3 \text{ V}$$

$$I_{R_1} = \frac{V_I - V_O}{R_1} = \frac{5 - 3.3}{1.7 \text{ k}\Omega} = 1 \text{ mA}$$

$$I_{D_2} = \frac{V_O - V_f}{R_2} = \frac{3.3 - 0.7}{4 \text{ k}\Omega} = 0.65 \text{ mA}$$

$$I_{D_1} = I_{D_2} - I_{R_1} = 0.65 - 1 = -0.35 \text{ mA} \quad \text{must be off.}$$

D_1 off, D_2 on

$$I_{D_1} = 0$$

$$I_{D_2} = I_{R_2} = \frac{V_I - V_f}{R_1 + R_2} = \frac{5 - 0.7}{(1.7 + 4) \text{ k}\Omega} = 0.754 \text{ mA}$$

$$V_O = V_f + I_{D_2} R_2 = 0.7 + 0.754 \times 4 = 3.72 \text{ V}$$

CMPE 314 Midterm Exam I Solutions

P1

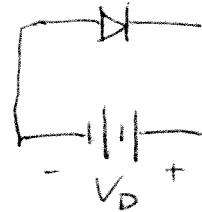
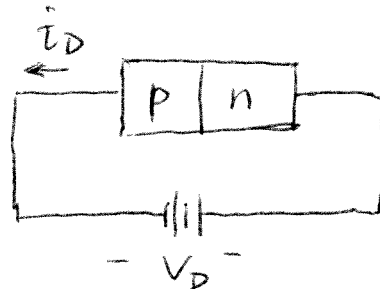
(a) Dope acceptor impurity (group III)

$$p_o \doteq N_a = 7 \times 10^{15} \frac{1}{\text{cm}^3}$$

$$n_o = \frac{n_i^2}{p_o} = \frac{(1.5 \times 10^{10})^2}{7 \times 10^{15}} = 3.2 \times 10^4 \frac{1}{\text{cm}^3}$$

Holes are majority carriers. Electrons are minority carriers.

(b)



I_D is due to minority carriers swept by the space-charge field (electrons from p-region and holes from the n-region).

P2

In forward bias

$$I_D = I_s (e^{V_D/V_T} - 1)$$

$$\approx I_s e^{V_D/V_T}$$

$$V_o = I_D R = I_s R e^{V_D/V_T}$$

$$V_D = V_T \ln\left(\frac{V_o}{I_s R}\right)$$

$$V_o = V_I - V_D = V_I - V_T \ln\left(\frac{V_o}{I_s R}\right)$$

