EE 115A Midterm Solutions

1.

- $0 < t \leq T/2$:

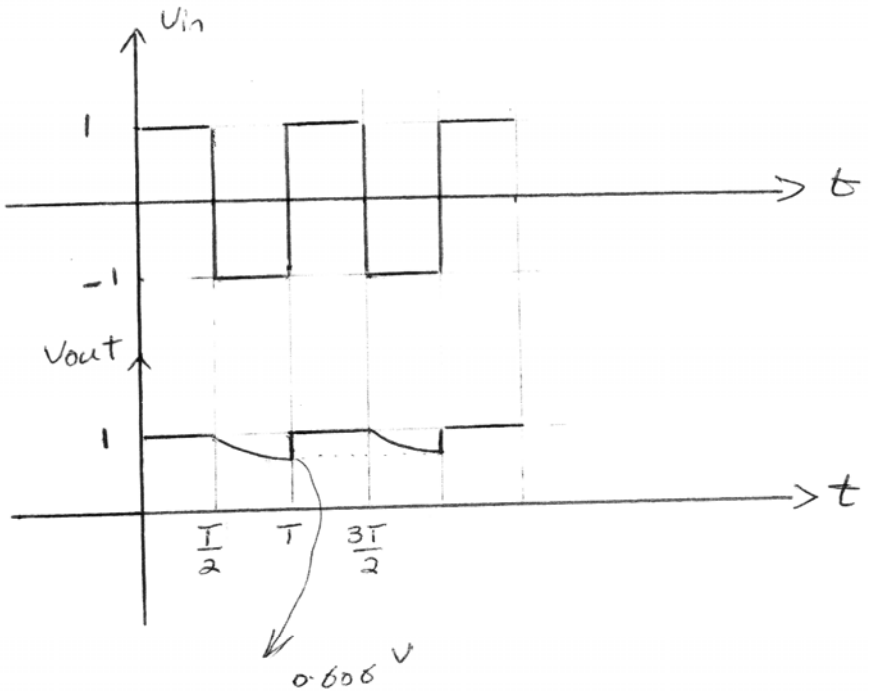
  $V_{in} = 1^V$ —> D_1 = ON —> V_{in} charges capacitor to 1^V.

- $T/2 < t \leq T$ —> D_1 turns OFF —> The capacitor voltage discharges through the resistor.

$$V_{out} = 1^V \times e^{\frac{-(t-T/2)}{RC}} \qquad \frac{T}{2} < t \leq T$$

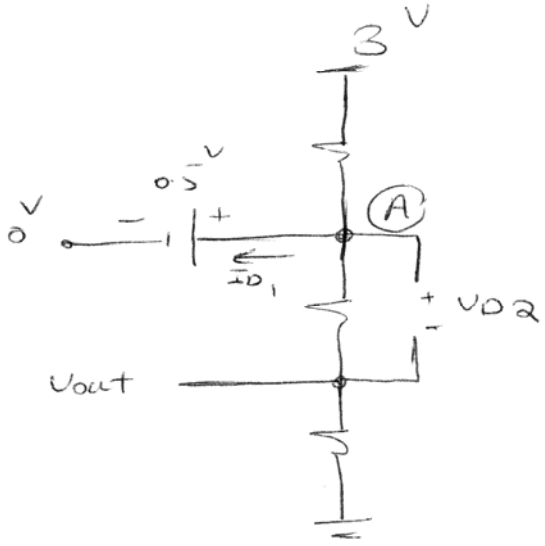
at $t = T$: $V_{out} = 1 \cdot e^{\frac{-T}{2RC}} = 1e^{-0.5} = 0.606^V$

The output is periodic.



2.

- $V_{in}=0$: $D_1=ON$
  $D_2=OFF$



$V_A = V_{in} + 0.5^V = 0.5^V$

$V_{out} = \frac{V_A}{2} = 0.25^V$

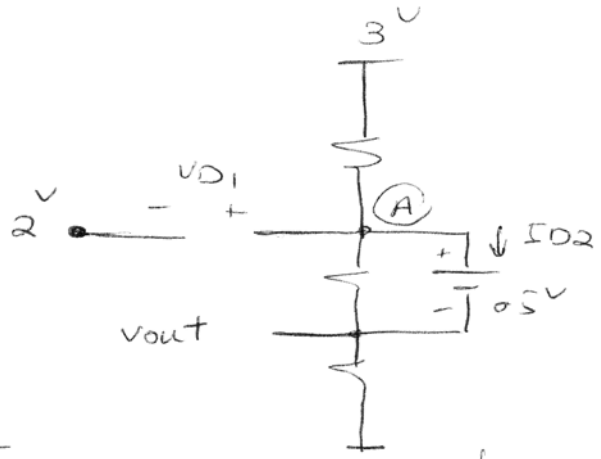
$I_{D_1} = \frac{3-V_A}{R} - \frac{V_A}{2R}$

$= \frac{3-3V_A}{2R} = \frac{1.5^V}{2R} > 0 \longrightarrow D_1=ON$ is correct.

$V_{D2} = V_A - V_{out} = 0.25^V < 0.5^V \longrightarrow D_2=OFF$ is correct.

- $V_{in}=2^V$: $D_1=OFF$
  $D_2=ON$

$V_{out} = \frac{3-0.5}{2} = 1.25^V$

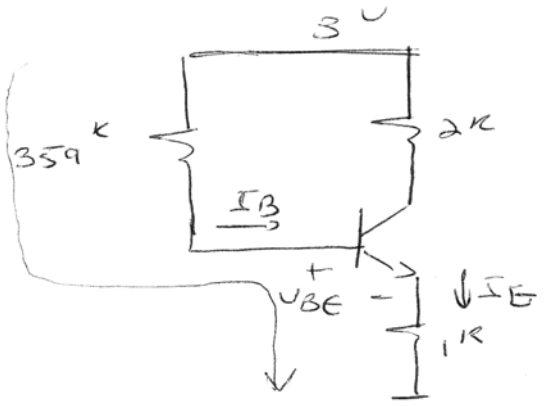


$V_A = 0.5^V + V_{out} = 1.75^V$

$V_{D_1} = V_A - V_{in} = 1.75 - 2 = -0.25 < 0.5 \longrightarrow D_1=OFF$ is correct.

$I_{D2} = \frac{V_{out}}{R} - \frac{0.5}{R} = \frac{0.75}{R} > 0 \longrightarrow D_2=ON$ is correct

3.



KVL:

$3^{V} = 359^{K} \times I_B + V_{BE} + 1^{K} \times I_E$

$$\begin{cases} V_{BE} = 0.7^{V} \\ I_E = (\beta+1) I_B = 101 I_B \end{cases}$$

$$\Rightarrow 3^{V} = 359^{K} \times I_B + 0.7^{V} + 1^{K} \times 101 \times I_B$$

$$\Rightarrow \begin{cases} I_B = 5\,\mu A \\ I_C = \beta I_B = 500\,\mu A \\ I_E = (\beta+1) I_B = 505\,\mu A \end{cases}$$

$$\begin{cases} V_C = 3^{V} - 2^{K} \times I_C = 2^{V} \\ V_B = 3^{V} - 359^{K} \times I_B = 1.205^{V} \\ V_E = 1^{K} \times I_E = 0.505^{V} \end{cases}$$

$V_{BC} = 1.205 - 2 = -0.795^{V}$ —> BC Reverse —> Q_1 Active

---

1.	10/40
2.	20/40
3.	10/40
Total	40/40