

Answers to EEE210 final exam AY2015-2016

1. (a) i. Replace Zener diode by its model. Then show

$$\begin{aligned} V_{in} < 0 &\Leftrightarrow \text{Zener forward biased} \\ 0 < V_{in} < 9 \text{ V} &\Leftrightarrow \text{Zener reverse biased off} \\ 9 \text{ V} < V_{in} &\Leftrightarrow \text{Zener reverse conduction} \end{aligned}$$

The given V_{out} vs V_{in} is easily obtained.

- ii. Zener diode is initially in reverse conduction. Then:

$$V_C(t) = 6 + 12 e^{-t/(2 \text{ ms})} \text{ V}$$

The state of the diode changes at 2.773 ms.

- (b) i. Set all DC values to 0, replace capacitors by short-circuits and replace diode by resistor R_{dynamic} .
 ii. $R_{\text{dynamic}} = \frac{n V_T}{I_{\text{source}}}$. Solve the circuit.
 iii. • $v_{out}(t) = 0.334 v_{in}(t)$
 • $v_{out}(t) = 0.4995 v_{in}(t)$
 • $v_{out}(t) = 0.991 v_{in}(t)$

2. (a)

$$\begin{aligned} I_D &= 2.646 \text{ mA} \\ V_{GS} &= 2.23 \text{ V} \\ V_{DS} &= 12.62 \text{ V} \end{aligned}$$

- (b)

$$\begin{aligned} R_E &= 3.3125 \text{ k}\Omega \\ R_C &= 4.6875 \text{ k}\Omega \end{aligned}$$

3. (a) Easy; refer to course notes.
 (b) Need emitter resistor as large as possible.
 (c)

$$\begin{aligned} I_{BQ} &= 50.4 \mu\text{A} \\ I_{CQ} &= 5.04 \text{ mA} \\ I_{EQ} &= 5.09 \text{ mA} \end{aligned}$$

- (d) $R_C = 2.679 \text{ k}\Omega$.
 (e) $R_{E\text{total}} = 500 \Omega$.
 (f) $V_{EQ} = 2.545 \text{ V}$.

(g)

$$R_1 = 31.1 \text{ k}\Omega$$

$$R_2 = 5.26 \text{ k}\Omega$$

(h) Need emitter resistor as small as possible.

(i) -145.7

$$(j) A_V = \frac{1.4421}{x-1.0099}.$$

$$(k) Z_{in} = 4.5 - \frac{0.40099}{1.09901-x}.$$

$$(l) Z_{out} = R_C, \forall x.$$

4. (a) Easy.

(b) i. $t_0 = 4.286 \text{ ns}$

ii. 3.365 ns

iii. 7.650 ns

iv. A.

$$\begin{aligned} t_1 &= R_{eq}C \ln(2) \\ &= 6.93147 \times 10^{-12} R_{eq} \end{aligned}$$

B. $R_{eq} = 1.104 \text{ k}\Omega$.