Answers to EEE210 final exam AY2018-2019

1. (a) **Figure (a)** $I = 0.86$ mA, $V = 0$ V (with ideal diodes we would find $I = 1.0$ mA, $V = 0$ V).

   Figure (b) $I = 0$ mA, $V = -3.5667$ V (with ideal diodes we would find $I = 0$ mA, $V = -3.3333$ V).

   (b) $V_D(0^+) = -12$ V $\Rightarrow$ D is initially reverse biased. D switches to forward biased at time $t_p = 13.8629$ ms. Finally:

$$V_o(t) = \begin{cases} 12 - 24\,\mathrm{e}^{-t/(20\text{ ms})}\text{ V} & \text{if } t \le t_p = 13.8629\text{ ms} \\ 0\text{ V} & \text{if } t \ge t_p = 13.8629\text{ ms} \end{cases}$$

   (c) Refer to course notes.

2. (a) $V_t = 1$ V, $K = 1$ mA/V^2.

   (b) Set all DC sources to 0, replace all capacitors by short-circuits, replace the MOSFET by its small signal AC model and redraw:

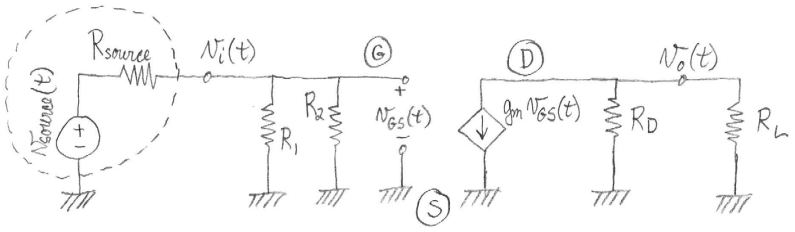


Figure 1:

   Voltage gain expression is easily obtained; refer to course notes. We require $R_D = 1$ kΩ, $g_m = 4$ m℧.

   (c) Set all DC sources to 0, replace all capacitors (except C_S) by short-circuits, replace the MOSFET by its small signal AC model and redraw:

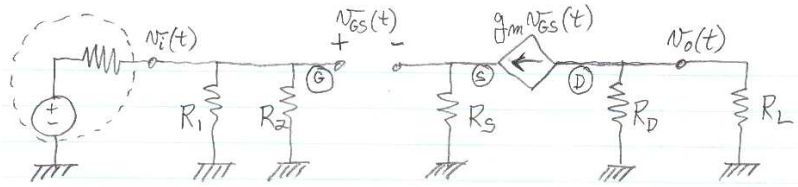


Figure 2:

   Voltage gain expression is easily obtained; refer to course notes. We require $R_S = 500$ Ω.

(d) $R_1 = R_2 = 24$ MΩ.

3. (a) Easy. Refer to notes.

   (b) Set all DC sources to 0, replace all capacitors by short-circuits, replace the BJT by its small signal AC model with:

$$h_{ie} = 240.55\ \Omega$$
$$h_{fe} = 99$$

   and redraw. Easy. Refer to notes.

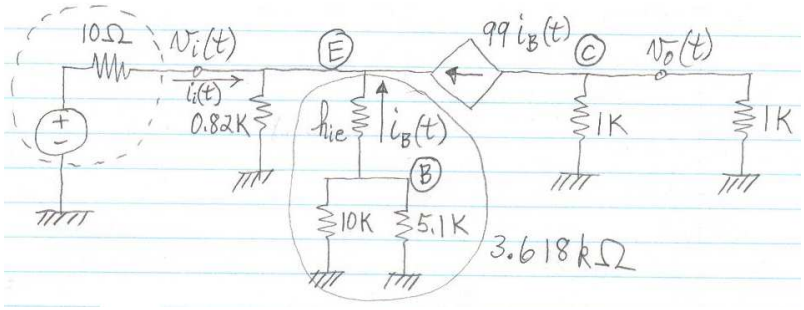


Figure 3:

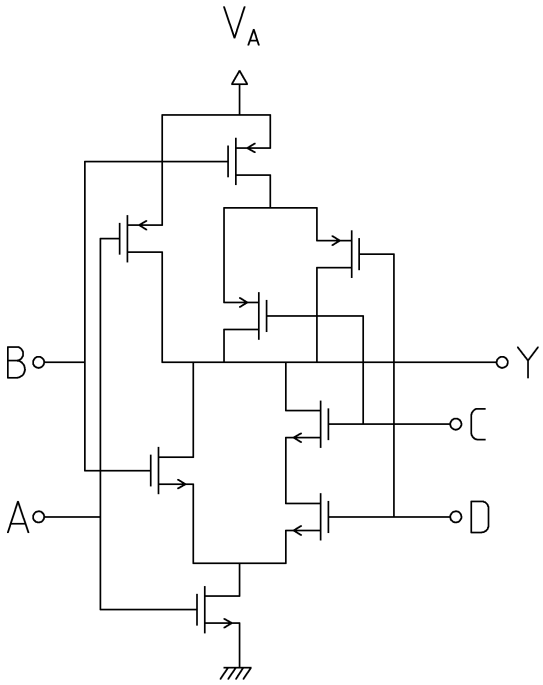
   (c) Easy. Refer to notes.

   (d) $Z_{in} = 34.651\ \Omega$, $Z_{out} = 1$ kΩ.

   (e) $A_I = 0.47409$, $A_P = 6.4866$.

   (f) $-0.382\ \text{V} < v_{in}(t) < 0.379\ \text{V}$.

4. (a)



(b) i. $t_0 = 4.286$ 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. $R_{eq} = 1.104$ kΩ.