

Question 1. a)

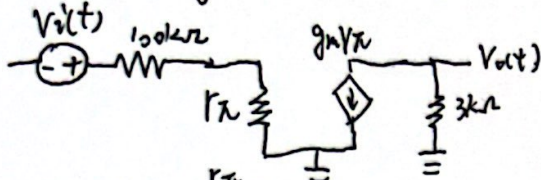
DC Analysis:

$$V_B = 0.7V$$

$$I_B = \frac{3V - 0.7V}{100k\Omega} = 0.0023A, I_C = \beta I_B = 0.0023A$$

$$\Rightarrow \frac{g_m}{\beta} = \frac{I_C}{V_T} = 0.08889s, r_\pi = \frac{\beta}{g_m} = 1124.8\Omega$$

With small-signal circuit model:



$$v_\pi = v_i(t) \cdot \frac{r_\pi}{r_\pi + 100k\Omega}$$

$$g_m v_\pi = -9.88 \times 10^{-4} v_i(t) \text{ (A)}$$

$$\Rightarrow v_o(t) = -2.96 v_i(t)$$

$$A_v = \frac{v_o(t)}{v_i(t)} = -2.96$$

Question 1 b).

DC Analysis:

$$\frac{5.8 - V_B}{5000} = \frac{1}{1001} \cdot \frac{V_B - 0.7}{5000}$$

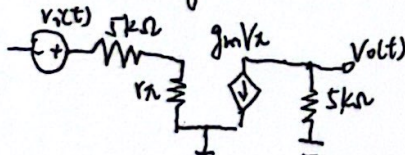
$$\Rightarrow V_B = 5.75V$$

$$\Rightarrow I_C = 1mA$$

$$g_m = \frac{I_C}{V_T} = 0.0386s$$

$$r_\pi = \frac{\beta}{g_m} = 2590.7\Omega$$

with small-signal circuit model:



$$g_m v_\pi = g_m \cdot v_i(t) \cdot \frac{2590.7}{5k\Omega + 2590.7} = 0.0132 \text{ (A)}$$

$$A_v = \frac{v_o(t)}{v_i(t)} = -65.806$$

Question 1 c).

DC Analysis: $V_{BE} = 0.7V$.

$$\Rightarrow V_E = 0.7V$$

$$I_E = 1.3 \times 10^{-4} A$$

$$I_C = \frac{100}{101} I_E = 0.208 \times 10^{-4} A$$

$$g_m = \frac{I_C}{V_T} = 0.00356$$

$$r_\pi = \frac{\beta}{g_m} = 2812.8\Omega$$

with small-signal circuit model:

