Mechatronics HW9

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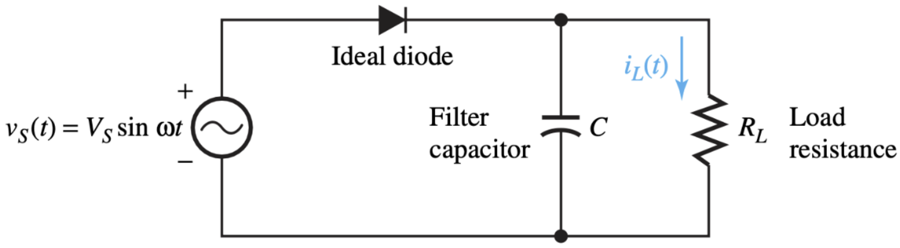
Problem 1

The input to the following circuit is $v_s(t) = V_s sin\omega t = 5sin10\pi t$. The capacitor is 0.1 μF and the resistor is 1 $M\Omega$. Please plot the voltage on the load resistor R_L in time domain in the figure below.



- $\omega = 10\pi$
- $T = 2\pi/\omega = 0.2s$
- $R_L = 1M\Omega = 1 \times 10^6\Omega$
- C $= 0.1\mu F = 0.1 \times 10^{-6}$

The time constant equals

$$\tau = R_L \times C$$

$$\tau = 1 \times 10^6 \times 0.1 \times 10^{-6} = 0.1s$$

At $0 < t < 0.05s$, as the source voltage initially increases positively, the diode is forward-biased since the load voltage is zero and the source is directly connected across the load. Once the source reaches its maximum value V_S and begins to decrease.

At $t = 0.5s$, the load voltage and the capacitor voltage are momentarily maintained at V_S, the diode becomes reverse-biased.

Then, the capacitor discharges from $0.05s$ to the next voltage increase interval.

During this interval, we apply KCL:

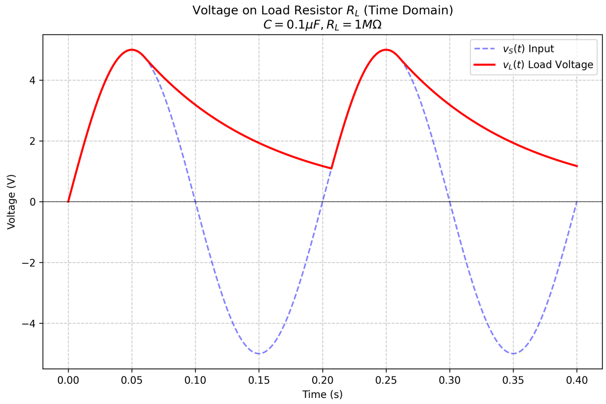
$$V_C - V_L = 0$$

$$V_C - R_LC\dot{V}_C = 0$$

Then we get:

$$V_C = 5e^{-\frac{1}{R_LC}(t-0.05)} = 5e^{-\frac{1}{\tau}(t-0.05)}$$

Where $\tau = 0.1s$. Thus the voltage on the load R_L is $5sin(10\pi t)$ when $0 < t < 0.05$, after 0.05 s, the voltage decreases until the source voltage $v_S(t)$ has increased to a value equal to the load voltage.



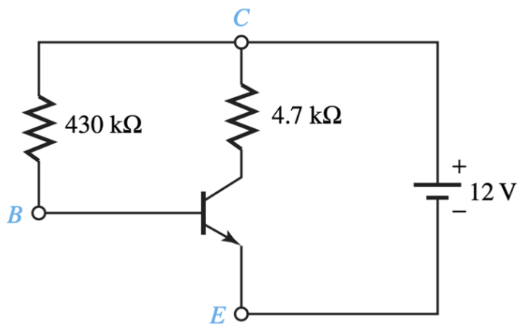
Problem 2

2. Consider the circuit of Figure below in which the silicon BJT has β= 85 and other typical values at room temperature.

(a) Compute i_B, i_C, and i_E.

(b) Check what happens if β is reduced by 10%.

(c) Check what happens if β is increased by 20%.



(a)

$$i_E = i_B + i_C$$
$$i_C = \beta i_B$$

We assume $V_{BE} = 0.07V$, we calculate the current in BC brunch:

$$i_B = \frac{V - 0.07}{430K} \approx 0.02628mA$$
$$i_C = \beta i_B \approx 2.2337mA$$
$$i_E = i_C + i_B = 2.26mA$$

(b)

$$i_C = (1 - 0.1)\beta i_B = 0.9\beta i_B = 2.01mA$$
$$i_E = i_B + i_C \approx 2.0366mA$$

(c)

$$i_C = 0.8\beta i_B \approx 1.787A$$
$$i_E = i_B + i_C = 1.813mA$$

Problem 3

Please process the data you collected from Lab task 2 and 3. Please plot the $I_B - I_C$ curve,$U_{GS} - I_D$curve.