`bjt_osc_1.sqproj`

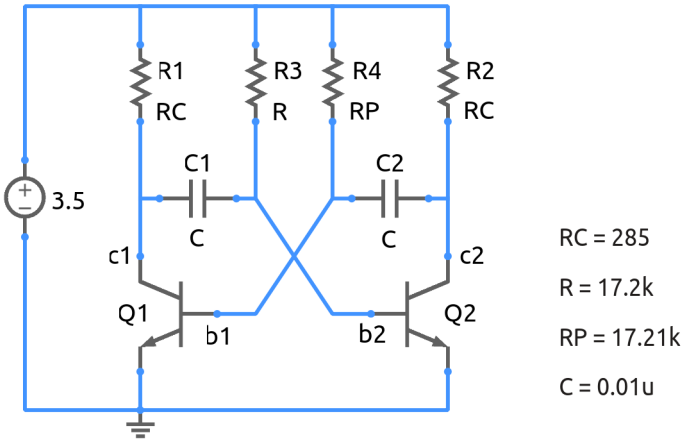

Figure 1: Oscillator circuit.

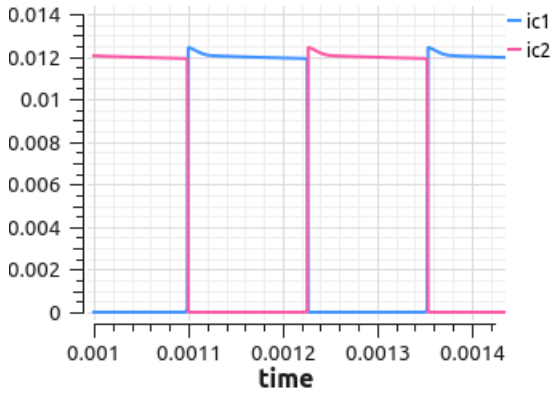

Figure 2: I_{C1} and I_{C2} versus time for the oscillator circuit of Fig. 1.

An oscillator circuit is shown in Fig. 1, and the associated waveforms are shown in Figs. 2, 3, 4. In this circuit, the transistors Q_1 and Q_2 conduct alternately. At $t = 1.1\,\text{msec}$ (referred to as t_1 in the following), Q_1 turns on, and Q_2 turns off. At $t = 1.225\,\text{msec}$ (referred to as t_2 in the following), Q_1 turns off, and Q_2 turns on.

During the interval $t_1 < t < t_2$, Q_1 is in saturation, and V_{C1} is equal to V_{CE}^{sat}, about 0.2 V. Since Q_2 is off, V_{C2} is pulled up to V_{CC}. Consider the transition from t_1^- to t_1^+, i.e., just before and just after the transistors change their states. At t_1^-, V_{C1} was equal to V_{CC}. Since Q_2 was on at

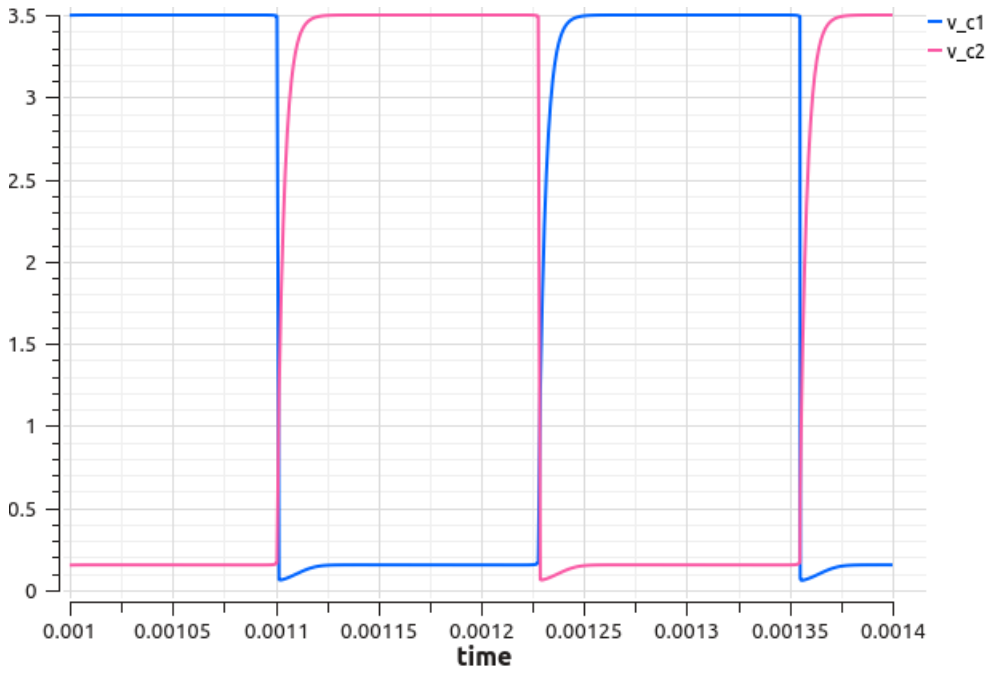

Figure 3: V_{C1} and V_{C2} versus time for the oscillator circuit of Fig. 1.

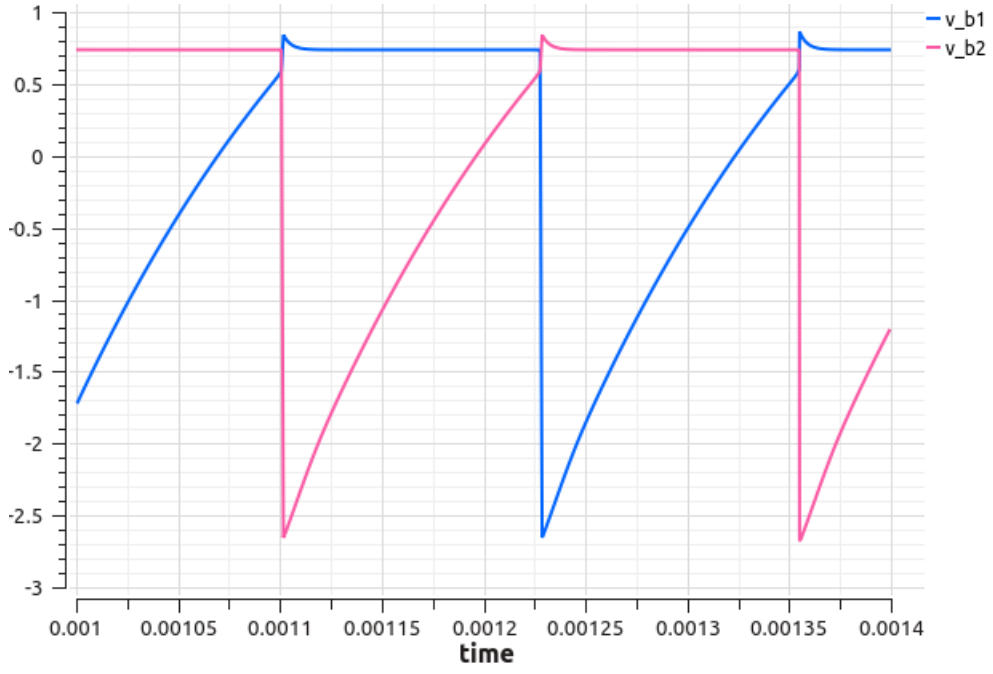

Figure 4: V_{B1} and V_{B2} versus time for the oscillator circuit of Fig. 1.

t_1^-, V_{BE2} was equal to about 0.7 V. At t_1^+, since Q_1 has turned on[1], V_{C1} changes to V_{CE}^{sat}. This

[1]It is assumed that the turning on or off of the BJT's is fast compared to the RC time constants in the

change in V_{C1} gets reflected in V_{B2} since the voltage across the capacitor C_1 cannot change instantaneously. We conclude that the new V_{BE2}, i.e., $V_{BE2}(t_1^+)$, must be 0.7 V-(V_{CC}-V_{CE}^{sat}). However, V_{B2} does not stay at the new value but starts increasing (toward V_{CC}) through the R_1-C_1 network. At t_2, V_{B2} becomes sufficiently large (about 0.6 V) to make Q_2 turn on, Q_1 turn off, and this cycle repeats.

Exercise Set

1. From the initial and final conditions on V_{B2}, estimate the time difference $t_2 - t_1$. Compare with the simulation result.

2. How would the plots change if the capacitance values (C_1 and C_2) are doubled?

3. How would the plots change if only C_1 is doubled?

References

1. D. A. Hodges and H. G. Jackson, *Analysis and Design of Digital Integrated Circuits,* McGraw-Hill, 1983.

circuit.