Conclusions concerning RC circuit

\[ v_R(t) = RC \frac{dv_C(t)}{dt} \]

Sinusoidal driving:
\[ v_T(t) = E_m \sin \omega t \quad \omega = 2\pi f \]

**Slow changes:** (low frequencies; \( f \ll \frac{1}{2RC} \))

- **Voltage is mostly across capacitor** \((v_C(t) \approx v_T(t); \quad v_R(t) \ll v_T(t))\)
- \(v_C(t)\) (\(\propto\) charge) lags \(v_T(t)\) by a bit
- \(v_R(t)\) (\(\propto\) current) leads \(v_T(t)\) by about \(\frac{1}{4}\) period
- **Differentiation circuit:** \(v_R(t) \approx RC \frac{dv_T(t)}{dt}\)
  \[\text{[holds for any slowly varying } v_T(t)\text{]}\]

**Fast changes:** (high frequencies; \( f \gg \frac{1}{2RC} \))

- **Voltage is mostly across resistor** \((v_R(t) \approx v_T(t); \quad v_C(t) \ll v_T(t))\)
- \(v_C(t)\) (\(\propto\) charge) lags \(v_T(t)\) by about \(\frac{1}{4}\) period
- \(v_R(t)\) (\(\propto\) current) leads \(v_T(t)\) by a bit
- **Integration circuit:** \(v_T(t) \approx RC \frac{dv_C(t)}{dt} \quad \Rightarrow \quad v_C(t) \approx \frac{1}{RC} \int v_T(t) \, dt\)
  \[\text{[holds for any rapidly varying } v_T(t)\text{]}\]

At all frequencies, \(v_R(t)\) leads \(v_C(t)\) by exactly \(\frac{1}{4}\) period