Lecture7:
Diode circuit

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PN junction

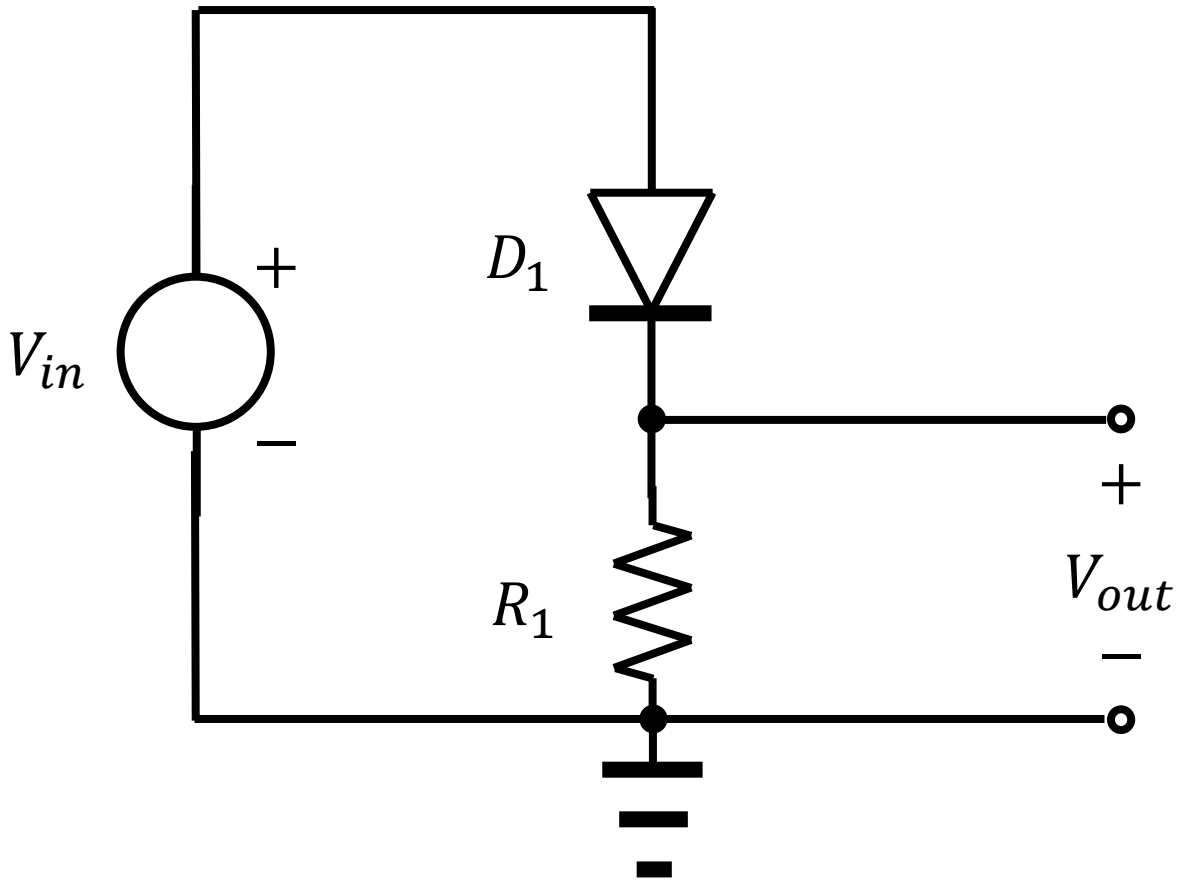
- Exponential model

$$I_D = I_s \left(\exp \frac{V_D}{V_T} - 1 \right)$$

- Constant-voltage model
  - An “offset” voltage of $V_{D,on}$

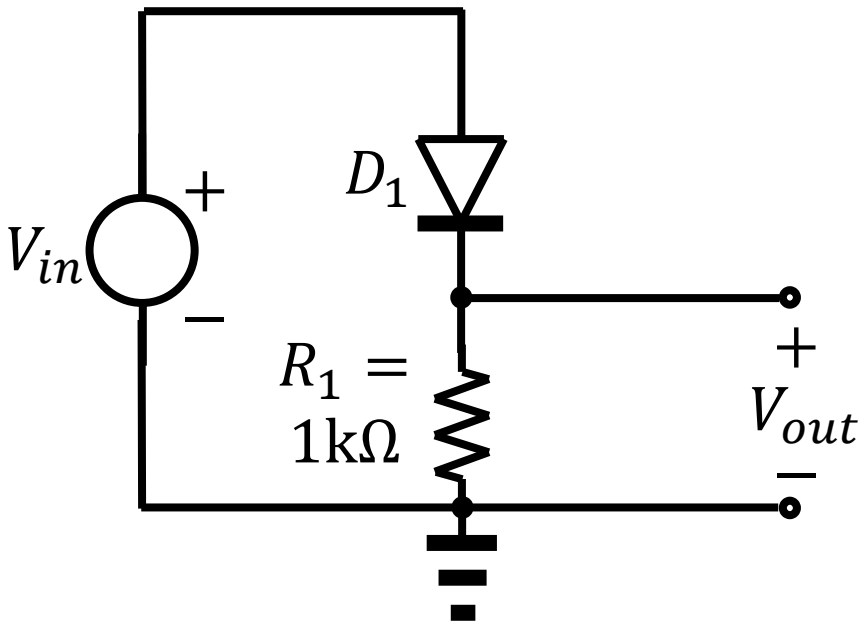
Rectifier

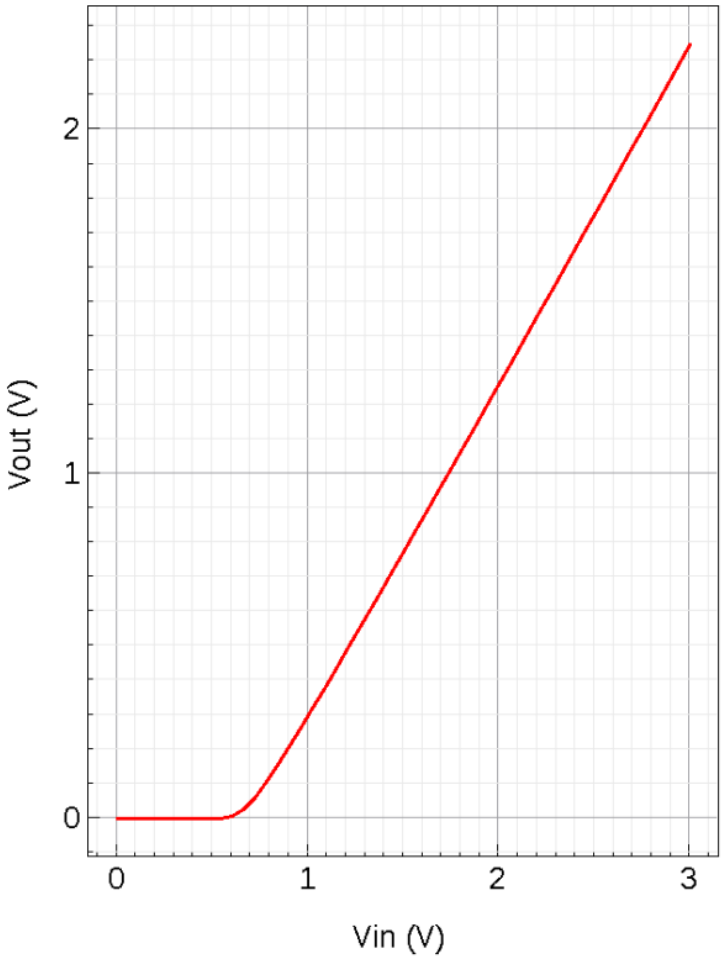
- Analyze it!
  - When $V_{in} < V_{D,on}$?
  - When $V_{in} > V_{D,on}$?



Simulation result

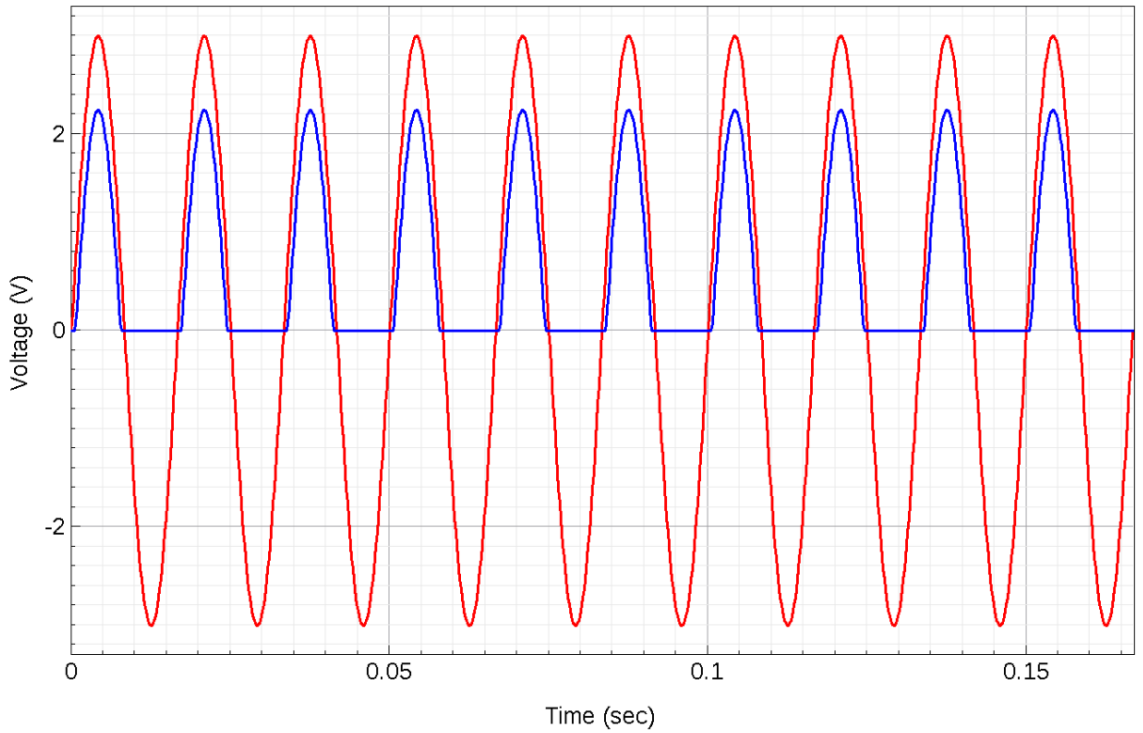
- Example) $I_s = 0.5$ fA and $R_1 = 1$ kΩ





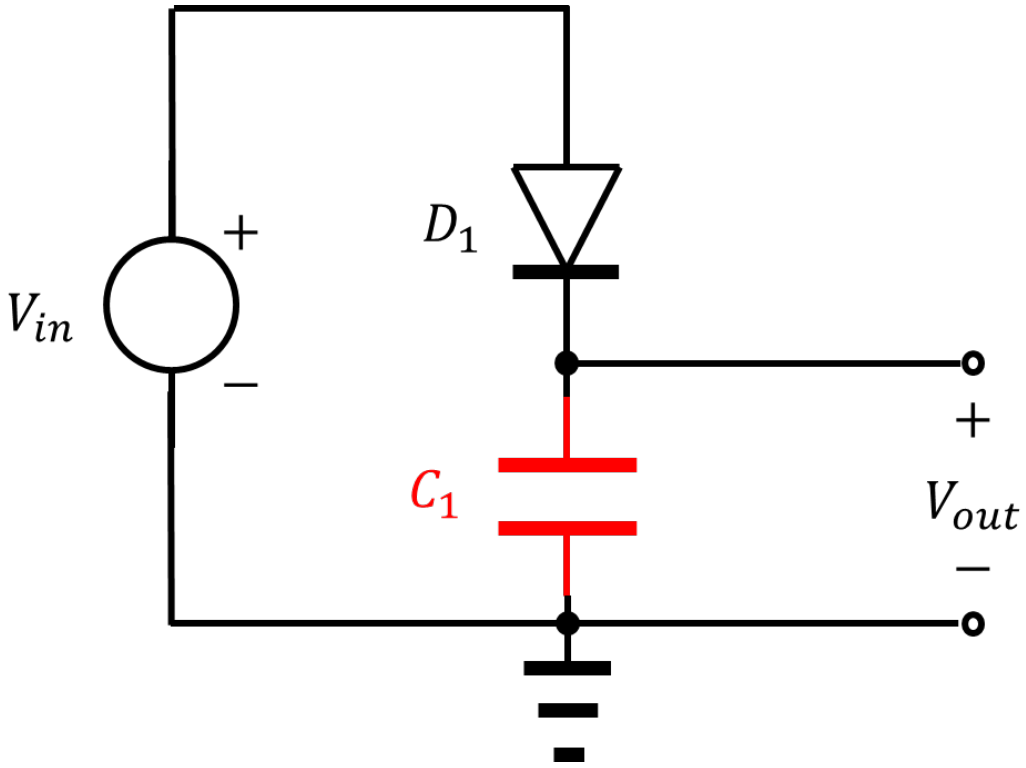
Time-varying voltage source

- For example, $V_{in}(t) = 3\sin(2\pi f t)$ V. 60 Hz. 10 periods



Introducing a capacitor

- Difference from the previous one?
  - First, consider the DC case.
  - Remember that $I_C = C_1 \frac{d}{dt} V_{out}$.



Qualitative understanding (1)

- Consider the first period.
  - When the input voltage exceeds $V_{D,on}$, the diode is turned on.
  - The charge is stored in the capacitor. Hence, the output voltage increases.
  - When the input voltage is lower than $V_{D,on}$, the output voltage does not change. (*Why?*)

Qualitative understanding (2)

- After the first period…
  - In the second period, the diode current is smaller than the one in the first period. (*Why?*)
  - After some periods, the diode current vanishes.
  - A DC output voltage is established.

Simulation result

- The capacitance, $C_1 = 1\ \mu\mathrm{F}$.