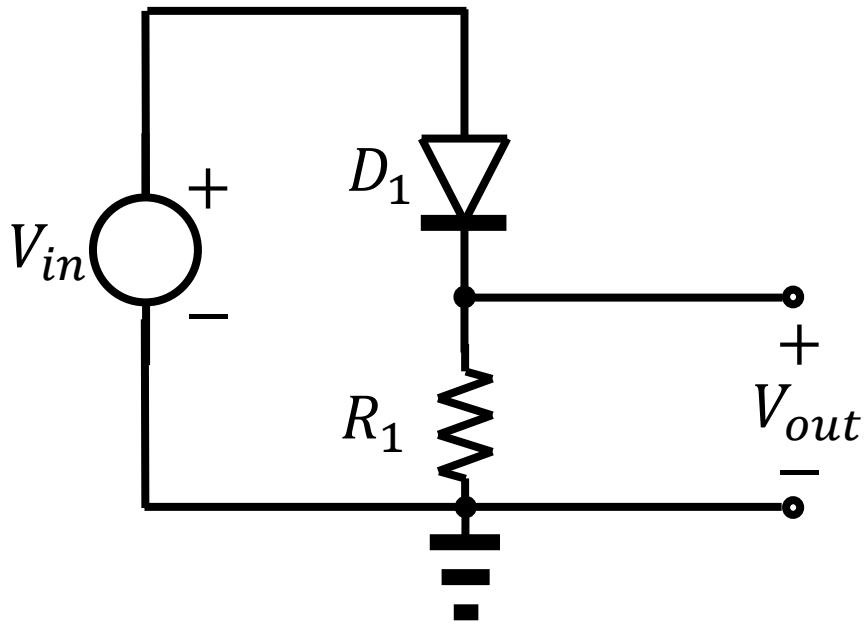
Computational Microelectronics
Lecture 24 Transient

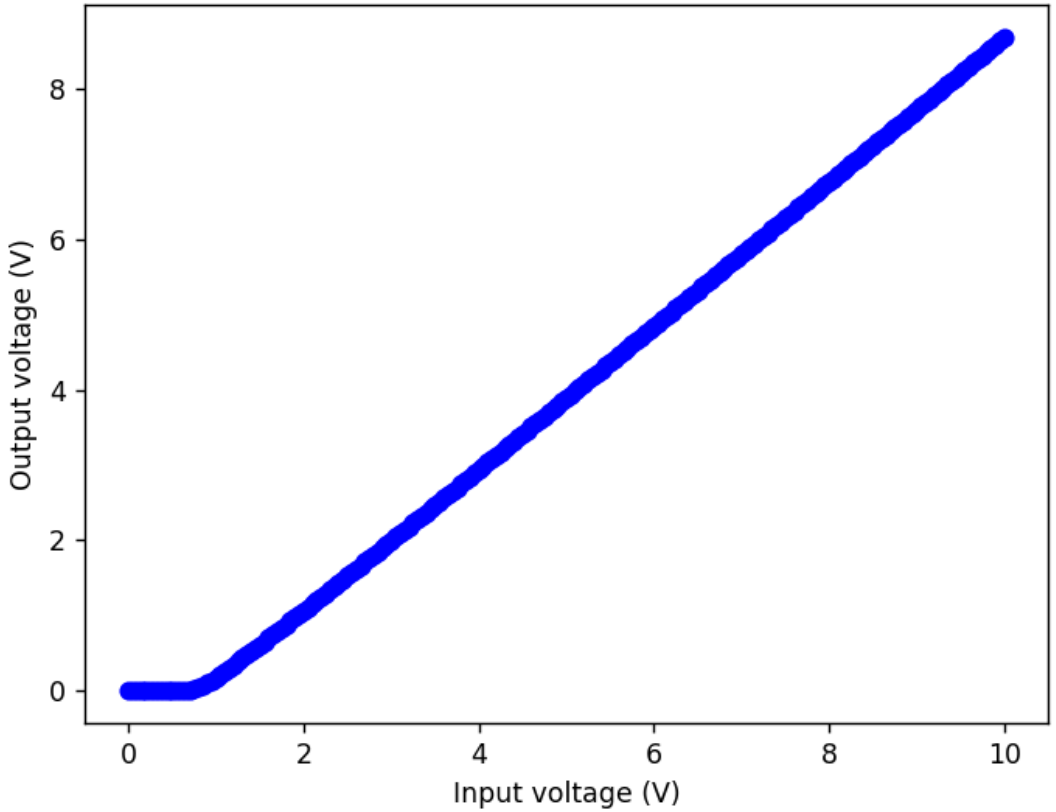
Sung-Min Hong (smhong@gist.ac.kr)
Semiconductor Device Simulation Laboratory
School of Electrical Engineering and Computer Science
Gwangju Institute of Science and Technology

Mixed-Mode Simulation

An example

- Consider a symmetric, abrupt PN junction. Its doping density is 10^{17} cm^{-3}. Assume that μ_n = 1417 cm^2/V sec and μ_p = 407.5 cm^2/V sec. The area is 1 μm^2. The resistor is 1 kΩ.
  - Increase the voltage up to 10 V.





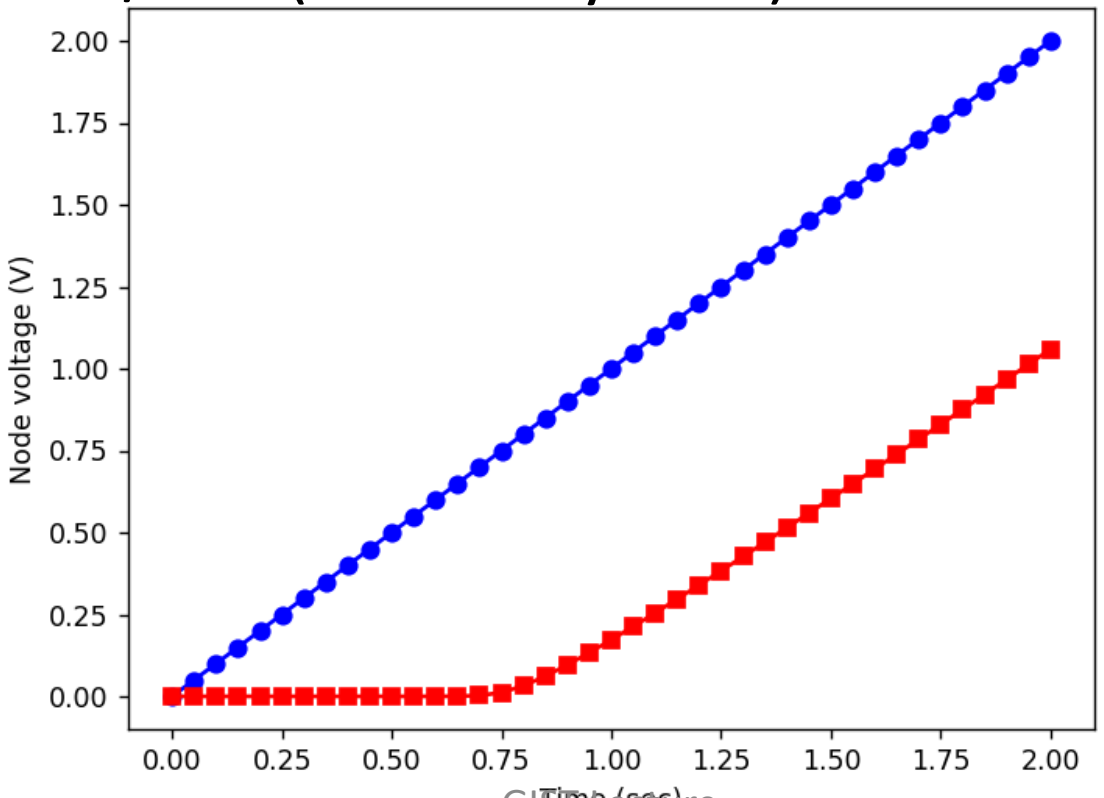
Convergence behavior

- When the Jacobian entries for the terminal current ($I_{cathode}$) are neglected,
  - We cannot get the converged solution at 0.8 V. (0.05 V spacing)
- When the Jacobian entries for the terminal current are neglected ($V_{cathode,internal} = -I_{cathode} \times R_{cathode}$),
  - We cannot get the convergence solution at 0.8 V. (0.05 V spacing)
- It is very important to consider $I_{cathode}$ and $V_{cathode,internal}$ accurately in the Jacobian matrix.

Transient Device Simulation

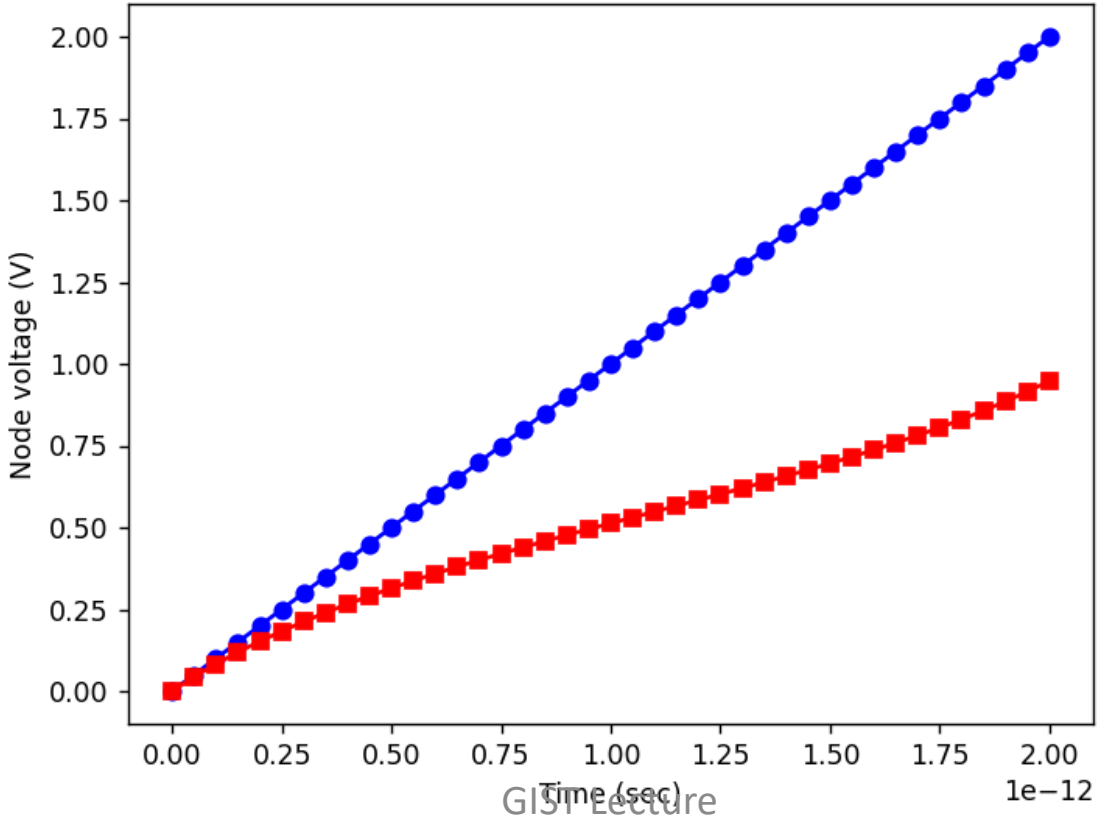
The same rectifier circuit

- The input voltage is increased up to 2 V.
  - The ramping rate is changed.
  - First, let's try 1 V/sec. (Extremely slow)



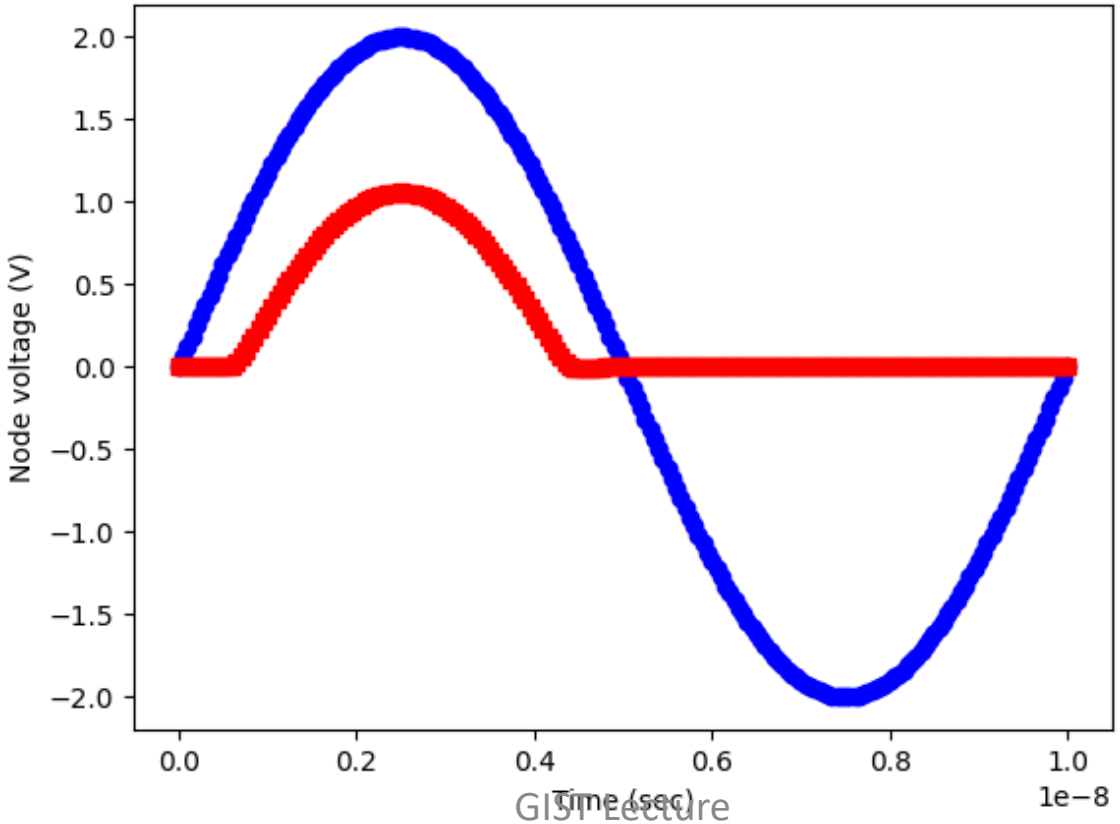
Much faster ramping

- The ramping rate is now 1 V/psec. (Extremely fast)
  - The PN junction cannot respond properly.



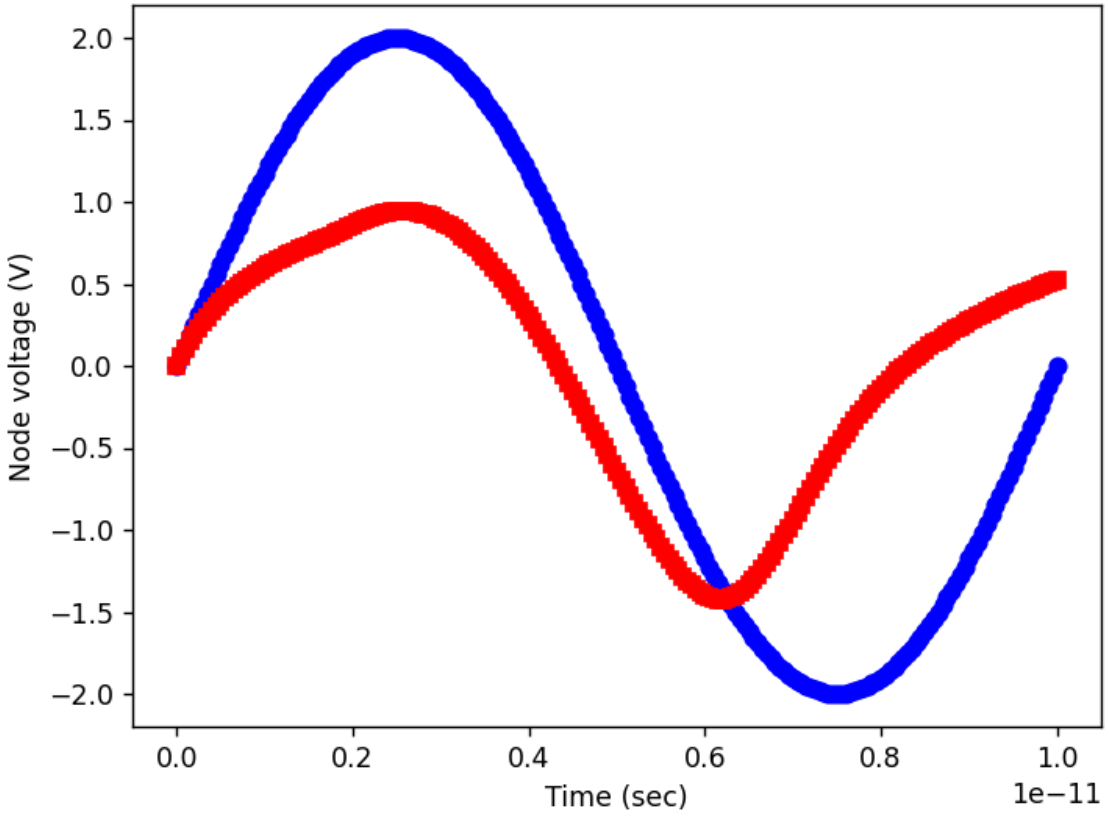
Sinusoidal signal

- We apply a sinusoidal signal whose amplitude is 2 V.
  - One period is divided into 200 intervals.
  - First, 100 MHz



Sinusoidal signal

- Once again, we try a much higher frequency, 100 GHz.
  - Its first period looks very different from 100 MHz.



Thank you!